EXHIBIT A

CyWee Group Ltd. v. Samsung Electronics Co., Ltd. et al.

Plaintiff's Claim Construction Presentation

April 17, 2018

Disputed Terms from U.S. Patent No. 8,441,438

- "utilizing a comparison to compare the first signal set with the second signal set" (claim 1)
- "comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T" (claims 14, 19)
- "three-dimensional (3D) pointing device"/"3D pointing device" (claims 1, 3, 4, 5, 14, 15, 16, 17, 19)
- "six-axis motion sensor"/"six-axis motion sensor module" (claims 1, 5, 14, 15, 16, 17, 19)

Disputed Terms from U.S. Patent No. 8,441,438

- "utilizing a comparison to compare the first signal set with the second signal set" (claim 1)
- "comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T" (claims 14, 19)
- "three-dimensional (3D) pointing device"/"3D pointing device" (claims 1, 3, 4, 5, 14, 15, 16, 17, 19)
- "six-axis motion sensor"/"six-axis motion sensor module" (claims 1, 5, 14, 15, 16, 17, 19)

Term within Claim 1

US008441438B2

(12) **United States Patent**
Ye et al.

(10) **Patent No.: US 8,441,438 B2**
(45) **Date of Patent: May 14, 2013**

(54) **3D POINTING DEVICE AND METHOD FOR COMPENSATING MOVEMENT THEREOF**

(75) Inventors: **Zhou Ye**, Foster City, CA (US); **Chin-Lung Li**, Taoyuan County (TW); **Shun-Nan Liou**, Kaohsiung (TW)

(73) Assignee: **Cywee Group Limited**, Tortola (VG)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 218 days.

(21) Appl. No.: **12/943,934**

(22) Filed: **Nov. 11, 2010**

(65) **Prior Publication Data**

US 2011/0163950 A1 Jul. 7, 2011

Related U.S. Application Data

(60) Provisional application No. 61/292,558, filed on Jan. 6, 2010.

(51) **Int. Cl.**
G09G 5/00 (2006.01)

(52) **U.S. Cl.**
USPC **345/156**

(58) **Field of Classification Search** .... None
See application file for complete search history.

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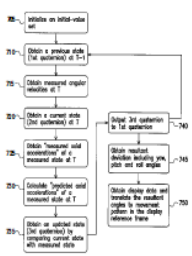
(74) *Attorney, Agent, or Firm* — Ding Yu Tan

(57) **ABSTRACT**

A three-dimensional (3D) pointing device capable of accurately outputting a deviation including yaw, pitch and roll angles in a 3D reference frame and preferably in an absolute manner is provided. Said 3D pointing device comprises a six-axis motion sensor module including a rotation sensor and an accelerometer, and a processing and transmitting module. The six-axis motion sensor module generates a first signal set comprising angular velocities and a second signal set comprising axial accelerations associated with said movements and rotations of the 3D pointing device in the 3D reference frame. The processing and transmitting module utilizes a comparison method to compare the first signal set with the second signal set to obtain an updated state of the six-axis motion sensor module based on a current state and a measured state thereof in order to output the resulting deviation in the 3D reference frame and preferably in an absolute manner.

19 Claims, 7 Drawing Sheets



1. A three-dimensional (3D) pointing device subject to movements and rotations in dynamic environments, comprising:

a processing and transmitting module, comprising a data transmitting unit electrically connected to the six-axis motion sensor module for transmitting said first and second signal sets thereof and a computing processor for receiving and calculating said first and second signal sets from the data transmitting unit, communicating with the six-axis motion sensor module to calculate a resulting deviation comprising resultant angles in said spatial pointer reference frame by utilizing a comparison to compare the first signal set with the second signal set whereby said resultant angles in the spatial pointer reference frame of the resulting deviation of the six-axis motion sensor module of the 3D pointing device are obtained under said dynamic environments, wherein the comparison utilized by the processing and transmitting module further comprises an update program to obtain an updated state based on a previous state associated with said first signal set and a measured state associated with said second signal set; wherein the measured state includes a measurement of said second signal set and a predicted measurement obtained based on the first signal set without using any derivatives of the first signal set.

"utilizing a comparison to compare the first signal set with the second signal set"

The Parties' Constructions

"utilizing a comparison to compare the first signal set with the second signal set"

CyWee's Construction	Samsung's Construction
"determining or assessing differences based on a previous state associated with the first signal set and a measured state associated with the second signal set while calculating deviation angles"	Indefinite

Law of Indefiniteness

- Indefiniteness must be proven by ***clear and convincing evidence***.

  Halliburton Energy Servs., Inc. v. M-I LLC, 514 F.3d 1244, 1249-50 (Fed. Cir. 2008); *Effective Expl., LLC v. Bluestone Nat. Res. II, LLC*, No. 216CV00607JRGRSP, 2017 WL 3193322 (E.D. Tex. July 27, 2017).

- A patent is indefinite only if it "fail[s] with ***reasonable certainty***, those skilled in the art about the scope of the invention. . . . ***[S]ome modicum of uncertainty*** is the price of ensuring the appropriate incentives for innovation."

  Nautilus, Inc. v. Biosig Instruments, Inc., 134 S. Ct. 2120, 2124-28 (2014).

- "A patentee need not define his invention with ***mathematical precision*** in order to comply with the definiteness requirement."

  Sonix Tech. Co. v. Publications Int'l, Ltd.,844 F.3d 1370, 1377 (Fed. Cir. 2017).

"utilizing a comparison to compare the first signal set with the second signal set"

CyWee's Construction: "Utilizing a Comparison"

The '438 patent describes an ***enhanced comparison method*** for ***comparing*** angular velocities and axial accelerations.

According to still another aspect of the present invention, the present invention provides an enhanced comparison method to correctly calculating and outputting a resulting deviation comprising a set of resultant angles including yaw, pitch and roll angles in a spatial pointer frame, preferably about each of three orthogonal coordinate axes of the spatial pointer reference frame, by comparing signals of rotation sensor related to angular velocities or rates with the ones of accelerometer related to axial accelerations such that these angles may be accurately outputted and obtained, which may too be further mapping to another reference frame different from said spatial pointer frame.

'438 Patent 4:31-42.

"utilizing a comparison to compare the first signal set with the second signal set"

CyWee's Construction: "Utilizing a Comparison"

- The Applicant acted as a ***lexicographer*** and defined "comparison."
- The enhanced comparison method ***does not require a direct comparison*** of axial accelerations and angular velocities but instead requires ***calculating*** and obtaining deviation angles.

effects or extra rotations about the axis related to "roll". The term of "comparison" of the present invention may generally refer to the calculating and obtaining of the actual deviation angles of the 3D pointing device **110** with respect to the first reference frame or spatial pointing frame $X_P Y_P Z_P$ utilizing signals generated by motion sensors while reducing or eliminating noises associated with said motion sensors; whereas

'438 Patent 2:26-32.

- Applicant's definition is reflected in CyWee's construction:

  "determining or assessing differences based on a previous state associated with the first signal set and a measured state associated with the second signal set ***while calculating deviation angles***"

"utilizing a comparison to compare the first signal set with the second signal set"

CyWee's Construction: "Utilizing a Comparison"

- CyWee's Construction is consistent with the understanding of a person of ordinary skill in the art.

18. "Comparison" of two values in mathematics and computer science generally refers to determining or assessing differences between those values as required by CyWee's construction. That determination may be a relation between them, e.g. they are equal or unequal and one is larger than the other. Comparison can also refer to assessing by what amount two values are different. This understanding is consistent with CyWee's construction, which requires "determining or assessing differences." One approach to this assessment would be to subtract one value from another to determine the difference. If two values cannot be directly compared, such as being in different units or different physical quantities, values can often be mapped or transformed to a common state/units/space before comparison. For example, when comparing

LaViola Dec. (Dkt. 66-6) ¶ 18.

- This understanding is reflected in CyWee's construction:

  "***determining or assessing differences*** based on a previous state associated with the first signal set and a measured state associated with the second signal set while calculating deviation angles"

"utilizing a comparison to compare the first signal set with the second signal set"

CyWee's Construction: "Utilizing a Comparison"

Other disclosures define the "comparison" as a "calculation":

said 3D pointing device. More particularly, the present invention relates to a 3D pointing device utilizing a six-axis motion sensor module with an enhanced comparison to calculate and compensate accumulated errors associated with the motion sensor module and to obtain actual resulting deviation angles in spatial reference frame and under dynamic environments.

'438 patent 1:21-26.

According to still another aspect of the present invention, the present invention provides an enhanced comparison method to correctly calculating and outputting a resulting deviation comprising a set of resultant angles including yaw, pitch and roll angles in a spatial pointer frame, preferably about each of three orthogonal coordinate axes of the spatial pointer reference frame, by comparing signals of rotation sensor related to angular velocities or rates with the ones of accelerometer related to axial accelerations such that these angles may be accurately outputted and obtained, which may too be further mapping to another reference frame different from said spatial pointer frame.

'438 patent 4:31-42.

Therefore, it is clear that an improved pointing device with enhanced calculating or comparison method capable of accurately obtaining and calculating actual deviation angles in the spatial pointer frame as well as mapping of such angles onto a pointer on the display frame in dynamic environments and conditions is needed. In addition, as the trend of 3D technol-

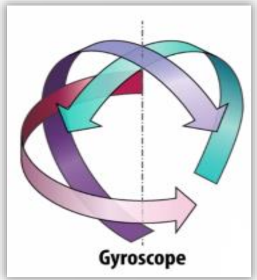
'438 patent 3:52-57.

"utilizing a comparison to compare the first signal set with the second signal set"

CyWee's Construction: "The First Signal Set"

- Claim 1 requires that:
  - The **first signal set** comprises **angular velocities** ωx, ωy, ωz originating from a **rotation sensor** (gyroscope).

> a six-axis motion sensor module attached to the PCB, comprising a rotation sensor for detecting and generating a first signal set comprising angular velocities ω_x, ω_y, ω_z associated with said movements and rotations of the 3D pointing device in the spatial pointer reference



  - The **previous state** is associated with **the first signal set**.

> comparison utilized by the processing and transmitting module further comprises an update program to obtain an updated state based on a previous state associated with said first signal set and a measured state associated

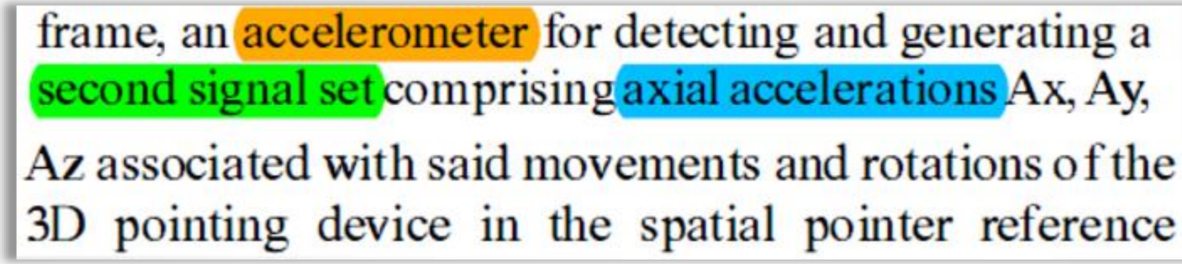
- This is reflected in CyWee's Construction:

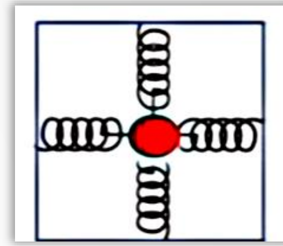
  "determining or assessing differences based on a **previous state** associated with **the first signal set** and a measured state associated with the second signal set while calculating deviation angles"

"utilizing a comparison to compare the first signal set with the second signal set"

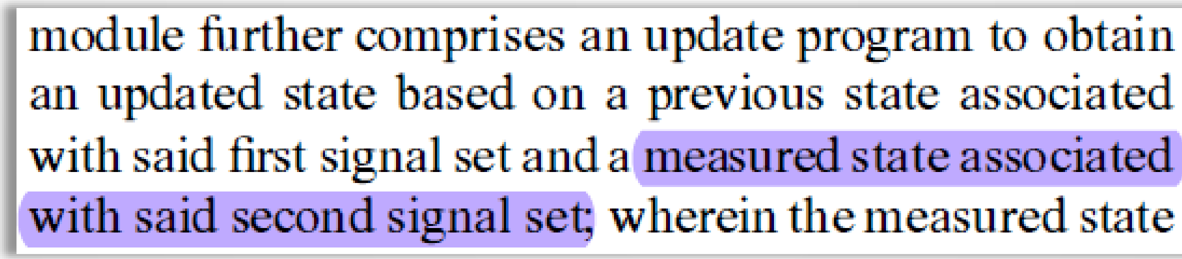
CyWee's Construction: "The Second Signal Set"

- Claim 1 requires that:
  - The **second signal set** comprises **axial accelerations** Ax, Ay, Az originating from an **accelerometer**.


frame, an accelerometer for detecting and generating a second signal set comprising axial accelerations Ax, Ay, Az associated with said movements and rotations of the 3D pointing device in the spatial pointer reference



  - The **measured state** is associated with **the second signal set**.


module further comprises an update program to obtain an updated state based on a previous state associated with said first signal set and a measured state associated with said second signal set; wherein the measured state

- This is reflected in CyWee's Construction:

  "determining or assessing differences based on a previous state associated with the first signal set and a **measured state** associated with **the second signal set** while calculating deviation angles"

"utilizing a comparison to compare the first signal set with the second signal set"

Samsung's Grounds are Based on Mistaken Assumptions

Samsung's Grounds:

1. The claim does not state the precise type of axial acceleration that is used.
2. It is impossible to decompose different types of acceleration (gravitational, linear, centrifugal).
3. A comparison of axial accelerations and angular velocities is "mathematically impossible."

"utilizing a comparison to compare the first signal set with the second signal set"

Samsung's Ground 1: The Claim Does not State the Type of Axial Acceleration

The '438 patent addresses ***all three types*** of axial acceleration (gravitational, linear, and centrifugal); none are excluded.

BACKGROUND OF THE INVENTION

device by Liberty cannot properly or accurately output the actual yaw, pitch and roll angles in the spatial reference frame $X_P Y_P Z_P$ and following which, consequently, the mapping of the spatial angles onto any 2D display reference frame such as $X_D Y_D Z_D$ may be greatly affected and erred. To be more specific, as the 5-axis compensation by Liberty cannot detect or compensate rotation about the X_P axis directly or accurately, the rotation about the X_P axis has to be derived from the gravitational acceleration detected by the accelerometer. Furthermore, the reading of the accelerometer may be accurate only when the pointing device is static since due to the limitation on known accelerometers that these sensors may not distinguish the gravitational acceleration from the acceleration of the forces including centrifugal forces or other types of additional accelerations imposed or exerted by the user.

'438 patent 3:1-15

"utilizing a comparison to compare the first signal set with the second signal set"

Samsung's Ground 1: The Claim Does not State the Type of Axial Acceleration

The '438 patent explicitly addresses undesirable accelerations.

pointing device along all of the X_P, Y_P and Z_P axes. In other words, the present invention is capable of accurately outputting the abovementioned deviation angles including yaw,

pitch and roll angles in a 3D spatial pointer reference frame of the 3D pointing device to eliminate or reduce accumulated errors and noises generated over time in a dynamic environment including conditions such as being subject to a combination of continuous movements, rotations, external gravity forces and additional extra accelerations in multiple directions or movement and rotations that are continuously non-linear with respect to time; and furthermore, based on the

'438 patent 4:65-5:8.

"utilizing a comparison to compare the first signal set with the second signal set"

Samsung's Ground 1: The Claim Does not State the Type of Axial Acceleration

- Samsung had no problem understanding this term when it agreed that:
  - "the measured state includes a measurement of said second signal set and a predicted measurement . . ." may be construed as "the measured state includes a measurement of ***axial accelerations*** and predicted ***axial accelerations*** . . ."
  - "calculating predicted ***axial accelerations*** Ax', Ay', Az' . . ." has its plain and ordinary meaning.

  Dkt. 75-1 at 4-5.

- Samsung was capable of understanding the term "axial acceleration" when it alleged invalidity by over 80 references in its ***8,000 pages*** of invalidity contentions.

"utilizing a comparison to compare the first signal set with the second signal set"

Samsung's Ground 2: An Accelerometer Cannot Distinguish Between Different Types of Acceleration

- Samsung attempts to manufacture a limitation requiring that the accelerometer distinguish between different types of acceleration.
- Claim 1 contains no such requirement, and as described above, the patent readily acknowledges all three types:

pointing device along all of the X_P, Y_P and Z_P axes. In other words, the present invention is capable of accurately outputting the abovementioned deviation angles including yaw,

pitch and roll angles in a 3D spatial pointer reference frame of the 3D pointing device to eliminate or reduce accumulated errors and noises generated over time in a dynamic environment including conditions such as being subject to a combination of continuous movements, rotations, external gravity forces and additional extra accelerations in multiple directions or movement and rotations that are continuously nonlinear with respect to time; and furthermore, based on the

'438 patent 4:65-5:8.

"utilizing a comparison to compare the first signal set with the second signal set"

Samsung's Ground 3: Comparing Axial Accelerations and Angular Velocities is "Mathematically Impossible."

- Samsung's third ground incorrectly presumes that a ***direct comparison*** (no conversion) is required.
- But, as discussed previously the Applicant defined "comparison" to ***not require a direct comparison***.

effects or extra rotations about the axis related to "roll". The term of "comparison" of the present invention may generally refer to the calculating and obtaining of the actual deviation angles of the 3D pointing device **110** with respect to the first reference frame or spatial pointing frame $X_P Y_P Z_P$ utilizing signals generated by motion sensors while reducing or eliminating noises associated with said motion sensors; whereas

'438 Patent 2:26-32.

"utilizing a comparison to compare the first signal set with the second signal set"

Samsung's Ground 3: Comparing Axial Accelerations and Angular Velocities is "Mathematically Impossible."

In *CyWee v. Apple*, the Northern District of California explicitly held that a direct comparison is not required.

> specification explicitly defines the term "comparison"). Moreover, the Court is not persuaded that it is "mathematically impossible" to compare the signal sets. Defendant's position depends on an overly rigid construction of the term "signal sets" as "raw data from the signal sets." That two measurements are made using different units does not make it "mathematically impossible" to compare those measurements: Celsius may be converted to Fahrenheit, kilometers may be converted to miles, and grams may be converted to cups. So long as the '438 Patent informs a

Dkt. 66-4 (*CyWee v. Apple* claim construction order).

"utilizing a comparison to compare the first signal set with the second signal set"

Samsung's Ground 3: Comparing Axial Accelerations and Angular Velocities is "Mathematically Impossible."

Dr. LaViola confirms that a direct comparison is not required.

35. Regarding Dr. Mercer's third reason, his allegation that a person of ordinary skill in the art would have understood that it would be mathematically impossible to compare the angular velocities with the axial accelerations is incorrect in the context of the '438 patent's enhanced comparison method. I have already opined above that the '438 patent does not teach or require that a direct comparison between angular velocity and axial acceleration is used in the patents-in suit. Dr. Mercer focuses on the direct comparison between these two quantities.

Dr. LaViola Dec. (Dkt. 66-6).

"utilizing a comparison to compare the first signal set with the second signal set"

Samsung's Arguments Regarding Non-Rigid Objects are Irrelevant

16. Dr. Mercer does not dispute that the 3D pointing device itself is a rigid body but instead argues that bodies acting on the 3D pointing device could be considered non-rigid and would introduce accelerations other than gravitational acceleration including linear and centrifugal accelerations which would cause ambiguities. Once again, Dr. Mercer misses the point by not understanding that the patent discloses an enhanced estimator designed to handle these differences and any person of ordinary skill in the art would understand this concept. Thus, a non-rigid body acting on the 3D pointing device would not make any difference in the computation of the deviation angles of the 3D pointing device when using the "enhanced comparison method."

LaViola Reply Dec. (Dkt. 71-1) ¶ 16.

What moves, or acts upon a device through 3D space is not required to determine the device's movement/orientation. The device itself—using the patented invention—reveals its orientation. This is a key feature of the invention.

"utilizing a comparison to compare the first signal set with the second signal set"

The '438 Patent Discloses an Optimal Estimator to a POSITA

Dr. LaViola refers to the class of optimal estimators as EKFs for simplicity.

A. "utilizing a comparison to compare the first signal set with the second signal set" ('438 patent claim 1)

7. The '438 and '978 patents disclose, to a person of ordinary skill in the art, a method for dynamic estimation of the orientation of a moving object. Kalman filters and EKFs are quintessential recursive estimators (meaning they update existing estimates based on new measurements). They are optimal estimators under certain conditions and have been proven reliable and accurate in many fields. There are a variety of implementations and modifications that can be made to EKFs for various applications. Nevertheless, they all share a fundamental underlying structure, methodology and mathematical theory that a person of ordinary skill in the art would recognize. For simplicity, I will refer to this class of recursive estimators as EKFs going forward.

LaViola Reply Dec. (Dkt. 71-1) ¶ 7.

The Comparison of the '438 Patent Refers to an Optimal Estimator, Such as an Extended Kalman Filter

Dr. LaViola refuted Dr. Mercer's testimony and testified that numerous equations in the patent were equivalent to those commonly used in an EKF. LaViola Reply Dec. ¶¶ 11-13.

11. One can clearly see the similarities between the equations that describe components of an embodiment of the enhanced comparison method" in the '438 and '978 patents and the equations that describe the EKF equations found in Exhibit 7 from Dr. Mercer's deposition. In that exhibit, the predicted state estimate is equivalent to Equation 5 in the '438 and '978 patents. The

. . . .

12. Similarly, one can clearly see the similarities between the equations that describe the "enhanced comparison method" in the '438 and '978 patents and the equations that describe the EKF equations found in Exhibit 8 from Dr. Mercer's deposition. The first equation listed in

. . . .

13. Given these mathematical similarities, any person of ordinary skill in the art would understand that the "enhanced comparison method" disclosed in the '438 and '978 patents represent an estimator that includes components of an Extended Kalman Filter or close variation thereof. Since Dr. Mercer did not recognize the equations in Exhibits 7 and 8 from his deposition,

"utilizing a comparison to compare the first signal set with the second signal set"

Expert Qualifications

Dr. LaViola has significantly more expertise that Dr. Mercer in the relevant technical field.

Knowledge/Activity	Dr. LaViola	Dr. Mercer
Is familiar with fundamental EKF equations	Yes	No
Has worked with and implemented EKFs for over 15 years	Yes	No
Has written papers on Kalman filters and EKFs	Yes	No

"utilizing a comparison to compare the first signal set with the second signal set"

Expert Qualifications

Dr. LaViola has significantly more expertise that Dr. Mercer in the relevant technical field.

[redacted]

Mercer Depo: 29:5-8; 143:18-24; 151:18-152:1; 163:17-18; 163:21-22; 166:6-12

“utilizing a comparison to compare the first signal set with the second signal set”

Dr. LaViola's Testimony

The patented methods are designed to handle differences in acceleration. Equations 5-11 are equivalent to those used in an EKF, and provide a ***framework***.

26. To be more specific, as I stated in my deposition, the EKF is a framework, and there are many different ways that such a filter can be constructed and initialized. The foundational equations in the EKF, and equivalently Equations (5-11) in the '978 patent, are written in such a way that they are general. As I discussed in my previous declaration, the EKF is a set of mathematical equations that uses an underlying process model to estimate the current state of a system and then corrects the estimate using any available sensor measurements using a measurement model. Using this predictor-corrector mechanism, it approximates an optimal estimate due to the linearization of the process and measurement models.

LaViola Reply Decl. (Dkt. 71-1) ¶ 26.

"utilizing a comparison to compare the first signal set with the second signal set"

Dr. LaViola's Testimony

The claimed enhanced comparison method is designed to handle different types of acceleration.

15. The ’438 and ’978 patents plainly state that an accelerometer is subject to multiple sources of acceleration, thus justifying the need for an “enhanced comparison method” that can handle the measurement errors that stem from these different sources as well as other disturbances and noise. ’438 patent 4:65-5:8; ’978 patent 5:38-45. Since Dr. Mercer does not have sufficient expertise to understand estimators such as the EKF, he continues to opine that the different types of acceleration make the claim term indefinite, which is simply not the case. A person of ordinary skill would understand that the methods described in the patents are designed to handle different types of acceleration. An EKF or similar estimator can be designed to handle such differences, and a person of ordinary skill in the art would understand that. The enhanced comparison method described in the patent handles these errors to provide an optimal estimate for the deviation angles of the 3D pointing device.

LaViola Reply Decl. (Dkt. 71-1) ¶ 15.

“utilizing a comparison to compare the first signal set with the second signal set”

Dr. LaViola's Testimony

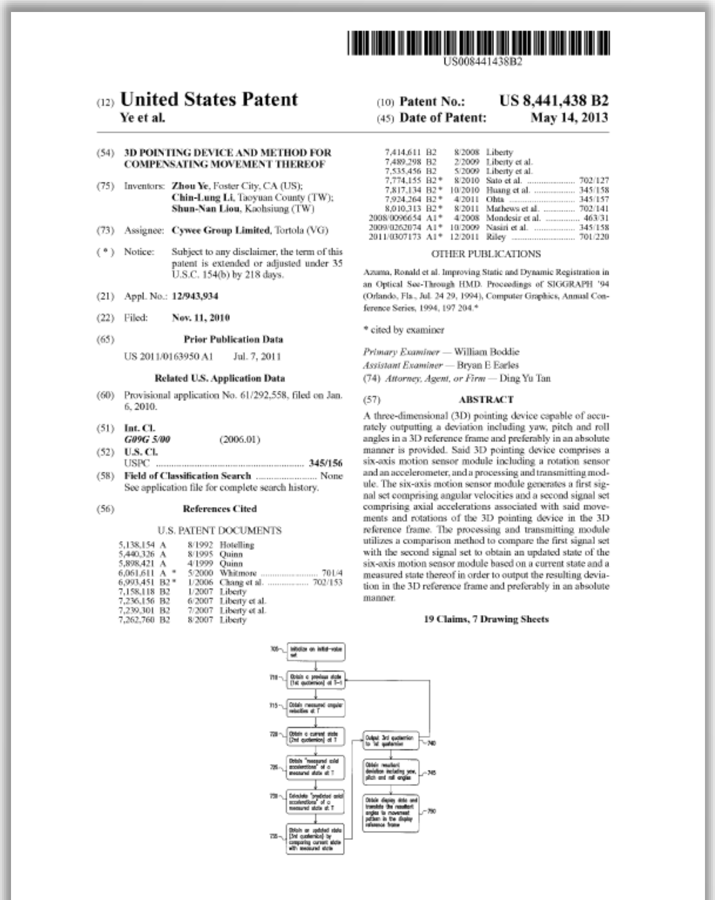
The patent discloses conversion of angular velocities and axial accelerations to a common state.

gyroscope) to the second signal set (i.e., accelerometer). Because the angular velocities and axial accelerations are different quantities, a person of ordinary skill in the art understands that a direct comparison of the angular velocities and axial accelerations is not performed. Rather, the comparison is done by conversion to a ***common state***, namely, the ***previous state*** (first quaternion) is updated using the angular velocities (first signal set) to generate a second quaternion. The second quaternion is used to generate predicted accelerations (***predicted state***), which are compared to the measured accelerations (***measured state*** or second signal set). *Id.* 3:53 (enhanced calculating or comparison method capable of accurately obtaining and calculating actual deviation angles in the spatial pointer frame), 3:63 (enhanced comparison method applicable to the processing of signals of motion sensors such that errors and/or noises associated with such signals or fusion of signals from the motions sensors may be corrected or eliminated);

LaViola Reply Decl. (Dkt. 71-1) ¶ 26.

"utilizing a comparison to compare the first signal set with the second signal set"

Embodiment of Figure 7: Common State



US008441438B2

(12) **United States Patent**
Ye et al.

(10) **Patent No.: US 8,441,438 B2**
(45) **Date of Patent: May 14, 2013**

(54) **3D POINTING DEVICE AND METHOD FOR COMPENSATING MOVEMENT THEREOF**

(75) Inventors: **Zhou Ye**, Foster City, CA (US); **Chin-Lung Li**, Taoyuan County (TW); **Shun-Nan Liou**, Kaohsiung (TW)

(73) Assignee: **Cywee Group Limited**, Tortola (VG)

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(21) Appl. No.: **12/943,934**

(22) Filed: **Nov. 11, 2010**

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USPC **345/156**

(58) **Field of Classification Search** .... None
See application file for complete search history.

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Primary Examiner — William Boddie
Assistant Examiner — Bryan E Earles
(74) *Attorney, Agent, or Firm* — Ding Yu Tan

(57) **ABSTRACT**

A three-dimensional (3D) pointing device capable of accurately outputting a deviation including yaw, pitch and roll angles in a 3D reference frame and preferably in an absolute manner is provided. Said 3D pointing device comprises a six-axis motion sensor module including a rotation sensor and an accelerometer, and a processing and transmitting module. The six-axis motion sensor module generates a first signal set comprising angular velocities and a second signal set comprising axial accelerations associated with said movements and rotations of the 3D pointing device in the 3D reference frame. The processing and transmitting module utilizes a comparison method to compare the first signal set with the second signal set to obtain an updated state of the six-axis motion sensor module based on a current state and a measured state thereof in order to output the resulting deviation in the 3D reference frame and preferably in an absolute manner.

19 Claims, 7 Drawing Sheets

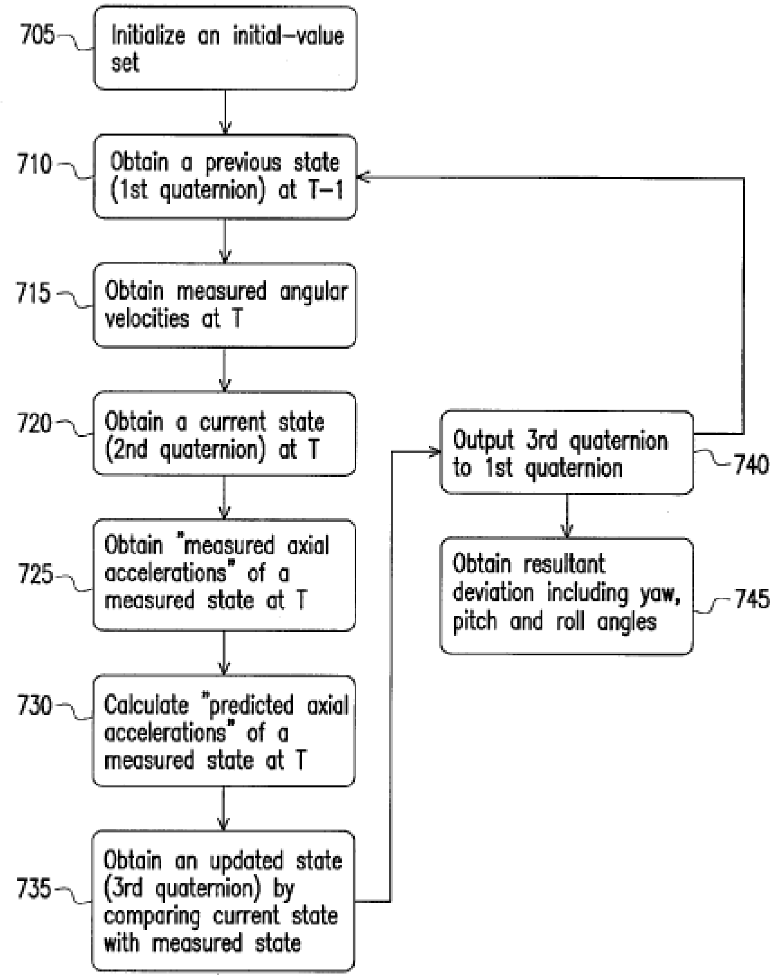
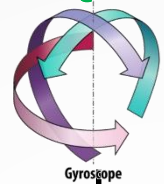


FIG. 7

"utilizing a comparison to compare the first signal set with the second signal set"

Embodiment of Figure 7: Common State

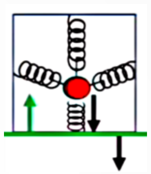
Measured Angular Velocity (1st Signal Set)



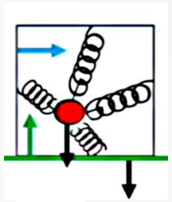
Comparison of Apples to Apples

Previous State (Orientation)

Current State (Orientation)



Predicted Axial Acceleration (Direction of gravity)



Measured Axial Acceleration (2nd Signal Set)

Measured State

Claim 1: "the comparison utilized by the processing and transmitting module further comprises an update program . . . wherein the **measured state** includes a **measurement of said second signal set** and a **predicted measurement obtained based on the first signal set** . . . ."

"utilizing a comparison to compare the first signal set with the second signal set"

Samsung's Newly-Cited Cases are Distinguishable

- Samsung relies on *Teva Pharmaceuticals USA, Inc. v. Sandoz, Inc.*, 789 F.3d 1335 (Fed. Cir. 2015), in which the patent did not disclose which definition of "molecular weight" applied.
  - Teva addressed a claim requiring that copolymers fall within a ***range*** of molecular weights.
  - Teva is also different because the patents-in-suit expressly state that the invention addresses ***all three types of axial acceleration***.
- Samsung relies on *Invensys Systems, Inc. v. Emerson Electric Co*., No. 6:12-cv-799, 2014 U.S. Dist. LEXIS 108401 (E.D. Tex. Aug. 6, 2014) for the premise that the patent requires a mathematically impossible calculation.
  - The Northern District of California rejected Apple's reliance on that case in its claim construction order because:
    1. CyWee defined a comparison as generally referring to "calculating and obtaining of the actual deviation angles" and
    2. the N.D. Cal. court was not convinced that the comparison was impossible because the raw data could be converted to a common state.

Dkt. 66-5 at p.8.

"utilizing a comparison to compare the first signal set with the second signal set"

Samsung's Allegations Lead to an Absurd Result

If Samsung's allegations were correct:

- Millions of modern cell phones, which include an accelerometer and a gyroscope could not fuse data from those sensors to compute orientation.

- Samsung, Apple, and other phone manufacturers include accelerometers ***and*** gyroscopes in their devices for one reason: to fuse data from those sensors.
  - Apple settled the case against it based on its use of CyWee's sensor fusion algorithm.

"utilizing a comparison to compare the first signal set with the second signal set"

Disputed Terms from U.S. Patent No. 8,441,438

- "utilizing a comparison to compare the first signal set with the second signal set" (claim 1)
- "comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T" (claims 14, 19)
- "three-dimensional (3D) pointing device"/"3D pointing device" (claims 1, 3, 4, 5, 14, 15, 16, 17, 19)
- "six-axis motion sensor"/"six-axis motion sensor module" (claims 1, 5, 14, 15, 16, 17, 19)

Term within Claims 14, 19

14. A method for obtaining a resulting deviation including resultant angles in a spatial pointer reference frame of a three-dimensional (3D) pointing device utilizing a six-axis motion sensor module therein and subject to movements and rotations in dynamic environments in said spatial pointer reference frame, comprising the steps of:

obtaining a measured state of the six-axis motion sensor module by obtaining measured axial accelerations Ax, Ay, Az gained from the motion sensor signals of the six-axis motion sensor module at the current time T and calculating predicted axial accelerations Ax', Ay', Az' based on the measured angular velocities ω_x, ω_y, ω_z of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities ωx, ωy, ωz; said current state of the six-axis motion sensor module is a second quaternion with respect to said current time T; comparing the second quaternion in relation to the measured angular velocities ω_x, ω_y, ω_z of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T;

19. A method for obtaining a resulting deviation including resultant angles in a spatial pointer reference frame of a three-dimensional (3D) pointing device utilizing a six-axis motion sensor module therein and subject to movements and rotations in dynamic environments in said spatial pointer reference frame, comprising the steps of:

obtaining a measured state of the six-axis motion sensor module by obtaining measured axial accelerations A_x, A_y, A_z gained from the motion sensor signals of the six-axis motion sensor module at the current time T and calculating predicted axial accelerations $A_{x'}$, $A_{y'}$, $A_{z'}$ based on the measured angular velocities ω_x, ω_y, ω_z of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities ω_x, ω_y, ω_z; said current state of the six-axis motion sensor module is a second quaternion with respect to said current time T; comparing the second quaternion in relation to the measured angular velocities ω_x, ω_y, ω_z of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T;

"comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T"

The Parties' Constructions

"comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T"

CyWee's Construction	Samsung's Construction
This term need not be construed. In the alternative, this term may be construed as: "utilizing the second quaternion obtained from the measured angular velocities ωx, ωy, ωz of the current state at current time T, the measured axial accelerations Ax, Ay, Az, and the predicted axial accelerations Ax', Ay', Az' also at current time T to obtain an updated state or updated quaternion."	Indefinite

"comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T"

'438 Patent Figure 7

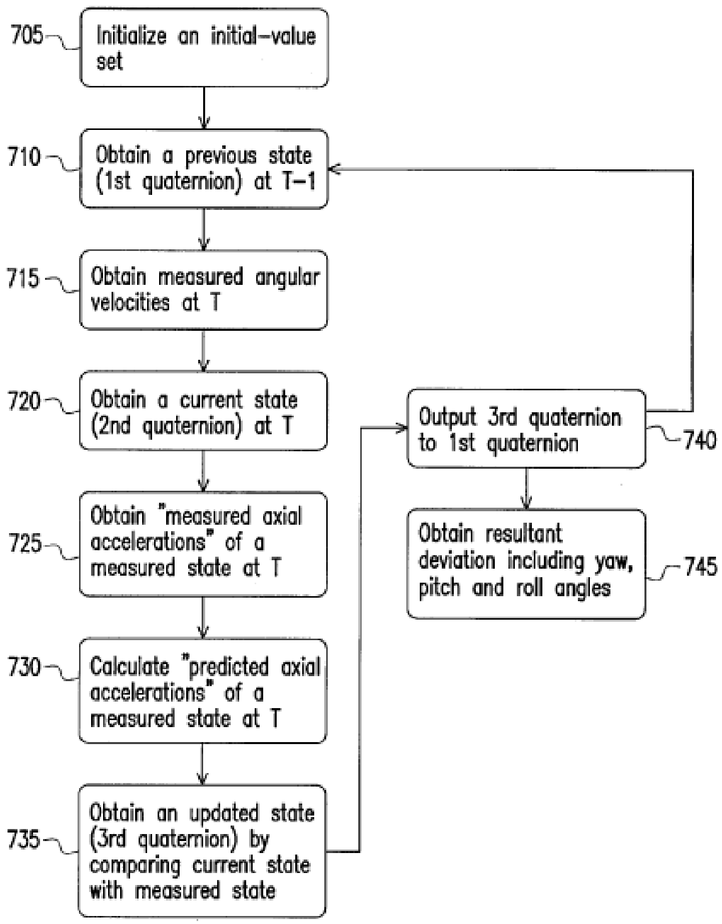


FIG. 7

<u>1st quaternion</u> represents the previous state (orientation at T-1) (step 710).

<u>2nd quaternion</u> represents the current state (orientation at T) (step 720).

<u>3rd quaternion</u> represents the updated state (step 735).

During subsequent iterations of the loop, the 3rd quaternion is output to the 1st quaternion. (step 740).

"comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T"

CyWee's Construction

- "**second quaternion** ***in relation to*** **measured angular velocities ωx, ωy, ωz** of the **current state** at current time T"

  is properly construed as:

  "**second quaternion** ***obtained from*** the **measured angular velocities ωx, ωy, ωz** of the **current state** at current time T" per the claims themselves:

- Claims 14 and 19 that (1) the **current state** is the **second quaternion** and (2) the current state is based on **measured angular velocities**.

> obtaining a current state of the six-axis motion sensor module by obtaining measured angular velocities ω_x, ω_y, ω_z gained from the motion sensor signals of the six-axis motion sensor module at a current time T;
>
> obtaining a measured state of the six-axis motion sensor module by obtaining measured axial accelerations Ax, Ay, Az gained from the motion sensor signals of the six-axis motion sensor module at the current time T and calculating predicted axial accelerations Ax', Ay', Az' based on the measured angular velocities ω_x, ω_y, ω_z of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities ωx, ωy, ωz; said current state of the six-axis motion sensor module is a second quaternion with respect to said current time T; comparing the second

"comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T"

CyWee's Construction

"***comparing the second quaternion*** . . . with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T."

is properly construed as

"***utilizing the second quaternion*** . . ., the measured axial accelerations Ax, Ay, Az, and the predicted axial accelerations Ax', Ay', Az' also at current time T ***to obtain*** an updated state or updated quaternion."

term of "comparison" of the present invention may generally refer to the calculating and obtaining of the actual deviation angles of the 3D pointing device **110** with respect to the first reference frame or spatial pointing frame $X_P Y_P Z_P$ utilizing signals generated by motion sensors while reducing or eliminating noises associated with said motion sensors; whereas

'438 patent 2:27-29.

"comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T"

Samsung and its Expert's Grounds of Indefiniteness

Samsung's first three arguments mimic those related to the term "utilizing a comparison to compare the first signal set with the second signal set."

1. The claim does not state the precise type of axial acceleration.
2. An accelerometer cannot distinguish between the three types of axial acceleration (gravitational, linear, centrifugal).
3. A comparison of axial accelerations and angular velocities is "mathematically impossible."
4. "Predicted axial accelerations" are indefinite for the same reasons as "axial accelerations."

"comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T"

Samsung's First Ground

1. The claim does not state the precise type of axial acceleration.

Samsung is mistaken because the patent readily acknowledges the different types of acceleration and the enhanced comparison method addresses those differences.

"comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T"

Samsung's Second Ground

2. An accelerometer cannot distinguish between the three types of axial acceleration (gravitational, linear, centrifugal).

The patent does not require this.

"comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T"

Samsung's Third Ground

3. A comparison of axial accelerations and angular velocities is "mathematically impossible."

A direct comparison is not required.

"comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T"

Samsung's Fourth Ground

4. "Predicted axial accelerations" are indefinite for the same reasons as "axial accelerations."

Samsung understood this term when it agreed that:

- "calculating predicted axial accelerations Ax', Ay', Az' . . ." has its plain and ordinary meaning.
- "the measured state includes a measurement of said second signal set and a predicted measurement . . ." may be construed as "the measured state includes a measurement of ***predicted axial accelerations***."

Dkt. 75-1 at 4-5.

Samsung also understood this term when it submitted voluminous (8000+ pages) of invalidity contentions.

Apple understood this term in *CyWee v. Apple.*

"comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T"

Samsung's Fourth Ground

Dr. LaViola testified that the predicted axial acceleration represents only ***gravitational acceleration***; there is no ambiguity.

23. In addition, Dr. Mercer fails to recognize that for the case of predicted axial accelerations described in the '438 and '978 patents, Equations 2-4 provide in the '438 and '978 patents an embodiment having a predicted axial acceleration, which is derived from the second quaternion that is computed from Equation 1, and this quaternion is derived from the first quaternion and the measured angular velocities (see Figures 7 and 8 in both patents). Since the predicted axial acceleration is derived from the second quaternion, and a person of ordinary skill in the art would understand that the second quaternion is normalized so that it represents orientation, then the predicted axial accelerations would represent and only represent axial accelerations that would stem from gravity (since gravitational acceleration is used to determine orientation). There would be no linear or centrifugal acceleration components as part of the predicted axial acceleration. Thus, Dr. Mercer's claim regarding the predicted axial accelerations is false, and even if it was true it still would not make any difference because the "enhanced comparison method" would deal with different types of acceleration regardless.

"comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T"

Disputed Terms from U.S. Patent No. 8,441,438

- "utilizing a comparison to compare the first signal set with the second signal set" (claim 1)
- "comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T" (claims 14, 19)
- "three-dimensional (3D) pointing device"/"3D pointing device" (claims 1, 3, 4, 5, 14, 15, 16, 17, 19)
- "six-axis motion sensor"/"six-axis motion sensor module" (claims 1, 5, 14, 15, 16, 17, 19)

Term within Claims 1, 3, 4, 5, 14, 15, 16, 17, 19

What is claimed is:

1. A three-dimensional (3D) pointing device subject to movements and rotations in dynamic environments, comprising:

a housing associated with said movements and rotations of the 3D pointing device in a spatial pointer reference frame;

a printed circuit board (PCB) enclosed by the housing;

a six-axis motion sensor module attached to the PCB, comprising a rotation sensor for detecting and generating a first signal set comprising angular velocities ω_x, ω_y, ω_z associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame, an accelerometer for detecting and generating a second signal set comprising axial accelerations Ax, Ay, Az associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame; and

a processing and transmitting module, comprising a data transmitting unit electrically connected to the six-axis motion sensor module for transmitting said first and second signal sets thereof and a computing processor for receiving and calculating said first and second signal sets from the data transmitting unit, communicating with the six-axis motion sensor module to calculate a resulting deviation comprising resultant angles in said spatial pointer reference frame by utilizing a comparison to compare the first signal set with the second signal set whereby said resultant angles in the spatial pointer reference frame of the resulting deviation of the six-axis motion sensor module of the 3D pointing device are obtained under said dynamic environments, wherein the comparison utilized by the processing and transmitting module further comprises an update program to obtain an updated state based on a previous state associated with said first signal set and a measured state associated with said second signal set; wherein the measured state includes a measurement of said second signal set and a predicted measurement obtained based on the first signal set without using any derivatives of the first signal set.

“three-dimensional (3D) pointing device”/”3D pointing device”

Term within Claims 1, 3, 4, 5, 14, 15, 16, 17, 19

3. The 3D pointing device of claim **1**, wherein the PCB enclosed by the housing comprises at least one substrate having a first longitudinal side configured to be substantially parallel to a longitudinal surface of the housing.

4. The 3D pointing device of claim **1**, wherein the spatial pointer reference frame is a reference frame in three dimensions; and wherein said resultant angles of the resulting deviation includes yaw, pitch and roll angles about each of three orthogonal coordinate axes of the spatial pointer reference frame.

5. The 3D pointing device of claim **1**, wherein the data transmitting unit of the processing and transmitting module is attached to the PCB enclosed by the housing and transmits said first and second signal of the six-axis motion sensor module to the computing processor via electronic connections on the PCB.

“three-dimensional (3D) pointing device”/”3D pointing device”

Term within Claims 1, 3, 4, 5, 14, 15, 16, 17, 19

14. A method for obtaining a resulting deviation including resultant angles in a spatial pointer reference frame of a three-dimensional (3D) pointing device utilizing a six-axis motion sensor module therein and subject to movements and rotations in dynamic environments in said spatial pointer reference frame, comprising the steps of:

obtaining a previous state of the six-axis motion sensor module; wherein the previous state includes an initial-value set associated with previous angular velocities gained from the motion sensor signals of the six-axis motion sensor module at a previous time T−1;

obtaining a current state of the six-axis motion sensor module by obtaining measured angular velocities ω_x, ω_y, ω_z gained from the motion sensor signals of the six-axis motion sensor module at a current time T;

obtaining a measured state of the six-axis motion sensor module by obtaining measured axial accelerations Ax, Ay, Az gained from the motion sensor signals of the six-axis motion sensor module at the current time T and calculating predicted axial accelerations Ax', Ay', Az' based on the measured angular velocities ω_x, ω_y, ω_z of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities ωx, ωy, ωz; said current state of the six-axis motion sensor module is a second quaternion with respect to said current time T; comparing the second quaternion in relation to the measured angular velocities ω_x, ω_y, ω_z of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T;

obtaining an updated state of the six-axis motion sensor module by comparing the current state with the measured state of the six-axis motion sensor module; and

calculating and converting the updated state of the six axis motion sensor module to said resulting deviation comprising said resultant angles in said spatial pointer reference frame of the 3D pointing device.

"three-dimensional (3D) pointing device"/"3D pointing device"

Term within Claims 1, 3, 4, 5, 14, 15, 16, 17, 19

15. The method for obtaining a resulting deviation of a 3D pointing device of claim **14**, further comprises the step of outputting the updated state of the six-axis motion sensor module to the previous state of the six-axis motion sensor module; and wherein said resultant angles of the resulting deviation includes yaw, pitch and roll angles about each of three orthogonal coordinate axes of the spatial pointer reference frame.

16. The method for obtaining a resulting deviation of a 3D pointing device of claim **14**, wherein said previous state of the six-axis motion sensor module is a first quaternion with respect to said previous time T−1; and said updated state of the six-axis motion sensor module is a third quaternion with respect to said current time T.

17. The method for obtaining a resulting deviation of 3D pointing device of claim **14**, wherein the obtaining of said previous state of the six-axis motion sensor module further comprises initializing said initial-value set.

“three-dimensional (3D) pointing device”/”3D pointing device”

Term within Claims 1, 3, 4, 5, 14, 15, 16, 17, 19

19. A method for obtaining a resulting deviation including resultant angles in a spatial pointer reference frame of a three-dimensional (3D) pointing device utilizing a six-axis motion sensor module therein and subject to movements and rotations in dynamic environments in said spatial pointer reference frame, comprising the steps of:

obtaining a previous state of the six-axis motion sensor module; wherein the previous state includes an initial-value set associated with previous angular velocities gained from the motion sensor signals of the six-axis motion sensor module at a previous time T−1;

obtaining a current state of the six-axis motion sensor module by obtaining measured angular velocities ω_x, ω_y, ω_z gained from the motion sensor signals of the six-axis motion sensor module at a current time T;

obtaining a measured state of the six-axis motion sensor module by obtaining measured axial accelerations A_x, A_y, A_z gained from the motion sensor signals of the six-axis motion sensor module at the current time T and calculating predicted axial accelerations $A_{x'}$, $A_{y'}$, $A_{z'}$ based on the measured angular velocities ω_x, ω_y, ω_z of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities ω_x, ω_y, ω_z; said current state of the six-axis motion sensor module is a second quaternion with respect to said current time T; comparing the second quaternion in relation to the measured angular velocities ω_x, ω_y, ω_z of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T;

obtaining an updated state of the six-axis motion sensor module by comparing the current state with the measured state of the six-axis motion sensor module; and

calculating and converting the updated state of the six axis motion sensor module to said resulting deviation comprising said resultant angles in said spatial pointer reference frame of the 3D pointing device.

"three-dimensional (3D) pointing device"/"3D pointing device"

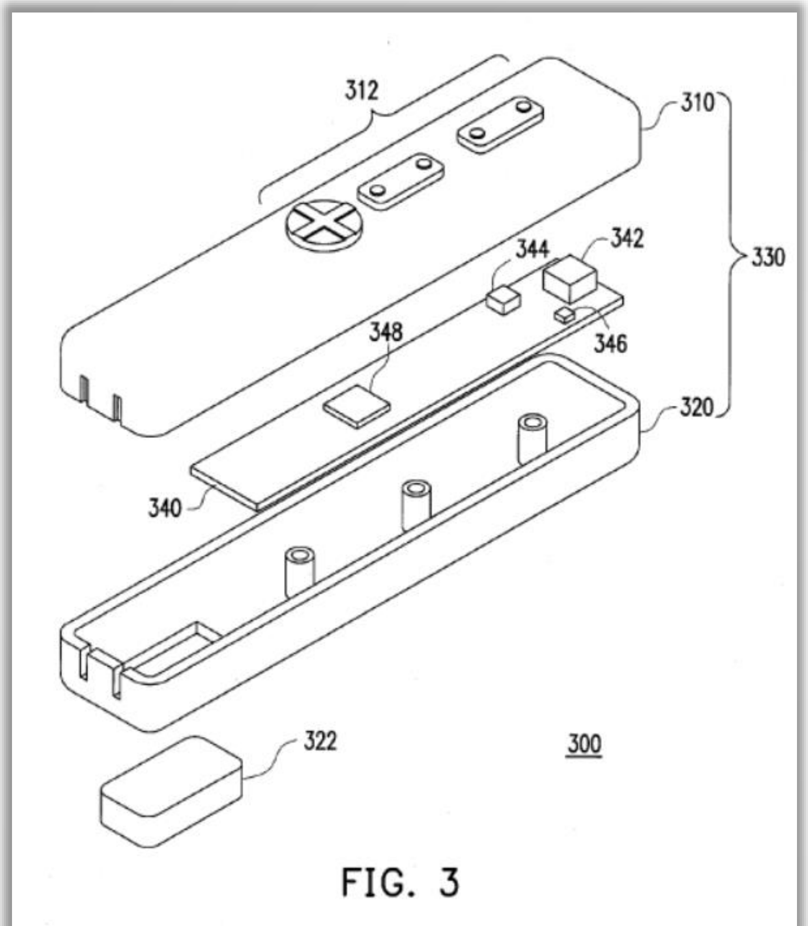
The Parties' Constructions

"three-dimensional (3D) pointing device"/"3D pointing device"

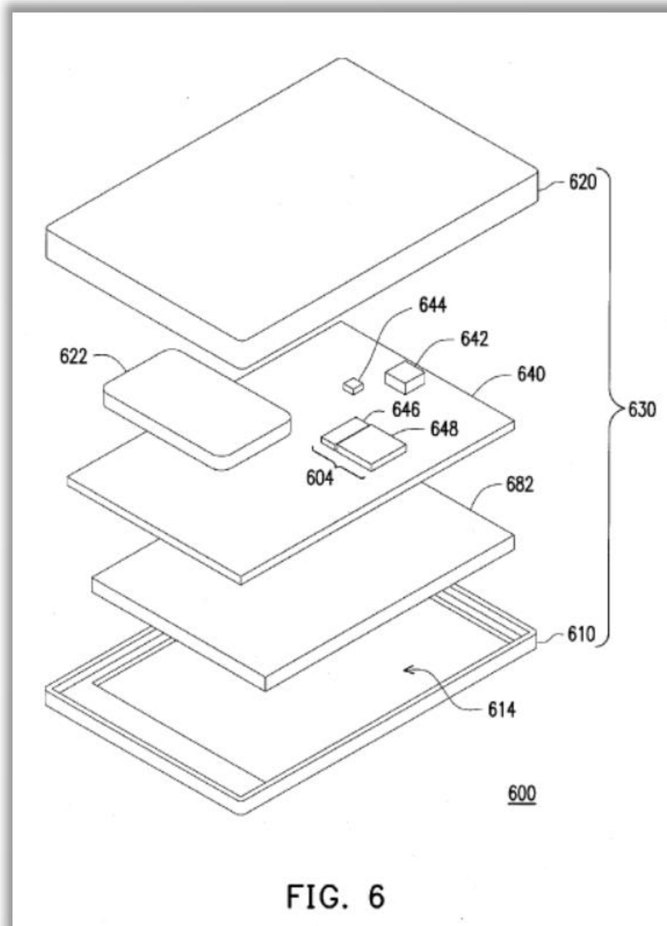
CyWee's Construction	Samsung's Construction
This term need not be construed. In the alternative, this term may be construed as: "a handheld device that uses at least a rotation sensor comprising one or more gyroscopes, and one or more accelerometers to determine deviation angles or the orientation of a device."	"a device that detects the motion of the device in three-dimensions and translates the detected motions to control the movement of a cursor or pointer on a display"

CyWee's Alternative Construction

"a handheld device . . ."



'438 Patent Fig. 3



'438 Patent Fig. 6

"three-dimensional (3D) pointing device"/"3D pointing device"

CyWee's Alternative Construction

"that uses a rotation sensor comprising one or more gyroscopes . . ."

comprising a rotation sensor for detecting and generating a first signal set comprising angular velocities ω_x,

'438 Patent Claim 1

another preferred embodiment, the abovementioned rotation sensor may comprise three gyroscopes corresponding to each of the said angular velocities of ω_x, ω_y, ω_z in a 3D spatial pointer reference frame of the 3D pointing device; whereas

'438 Patent 5:24-26

"three-dimensional (3D) pointing device"/"3D pointing device"

CyWee's Alternative Construction

" . . . and one or more accelerometers . . ."

frame, an accelerometer for detecting and generating a second signal set comprising axial accelerations Ax, Ay,

'438 Patent Claim 1

the abovementioned accelerometer may comprise three accelerometers corresponding to each of the said axial accelerations Ax, Ay, Az in a 3D spatial pointer reference frame of the 3D pointing device. The rotation sensor detects the rota-

'438 Patent 5:28-31

"three-dimensional (3D) pointing device"/"3D pointing device"

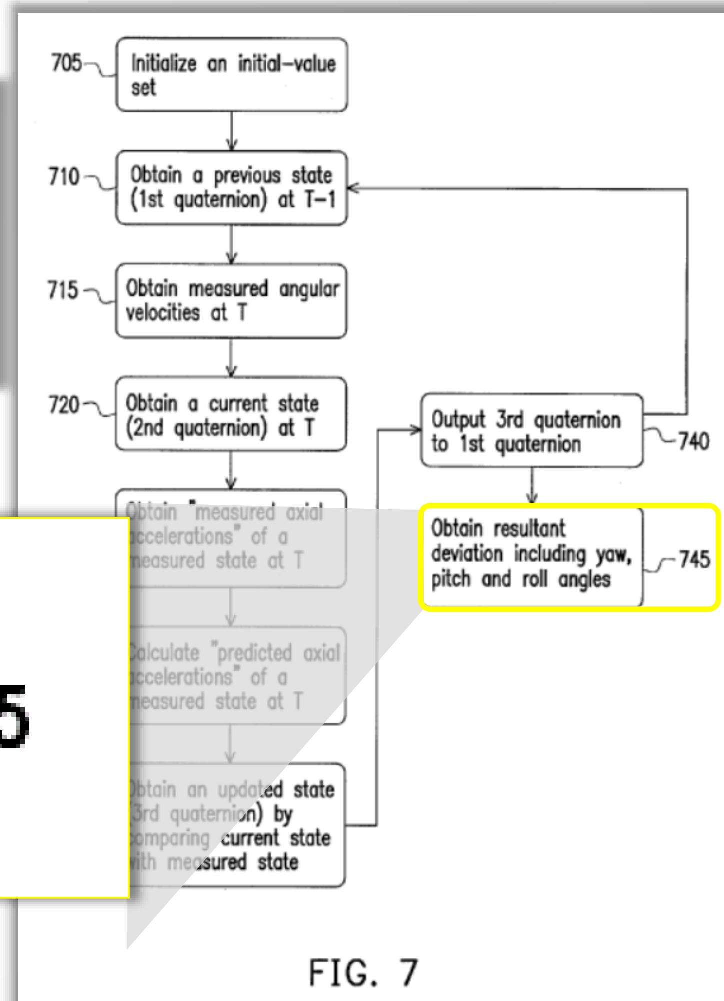
CyWee's Alternative Construction

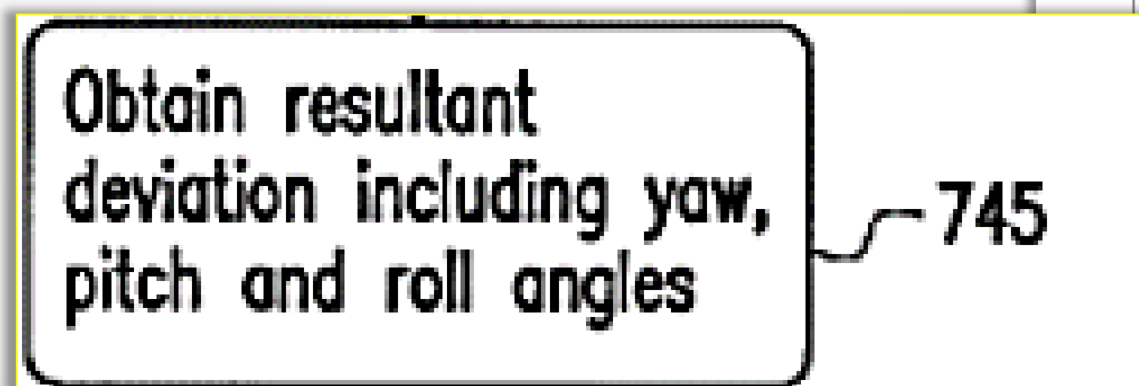
"to determine deviation angles or the orientation of a device"

(57) **ABSTRACT**

A three-dimensional (3D) pointing device capable of accurately outputting a deviation including yaw, pitch and roll angles in a 3D reference frame and preferably in an absolute manner is provided. Said 3D pointing device comprises a

'438 Patent Abstract





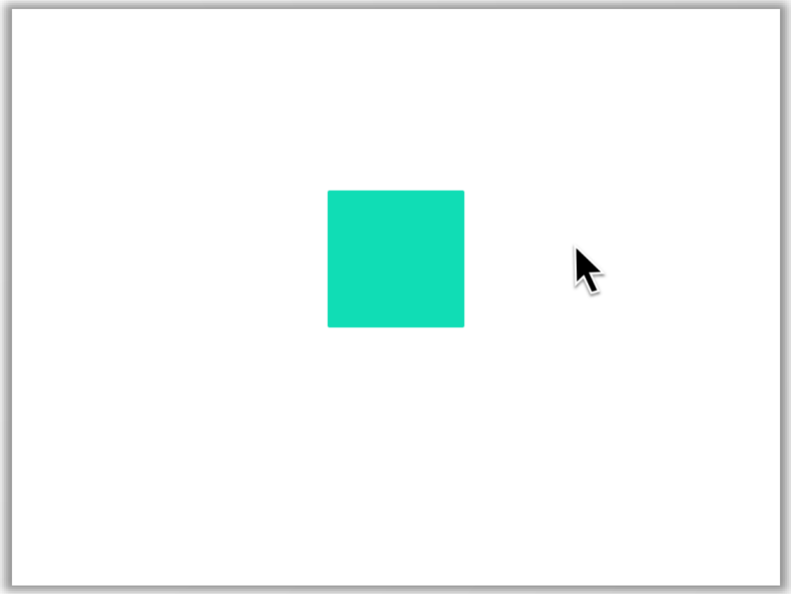
'438 Patent Fig. 7

"three-dimensional (3D) pointing device"/"3D pointing device"

Samsung's Construction: "cursor or pointer"

- A cursor is "a visible mark that is generated by the computer and that indicates a position on the display."

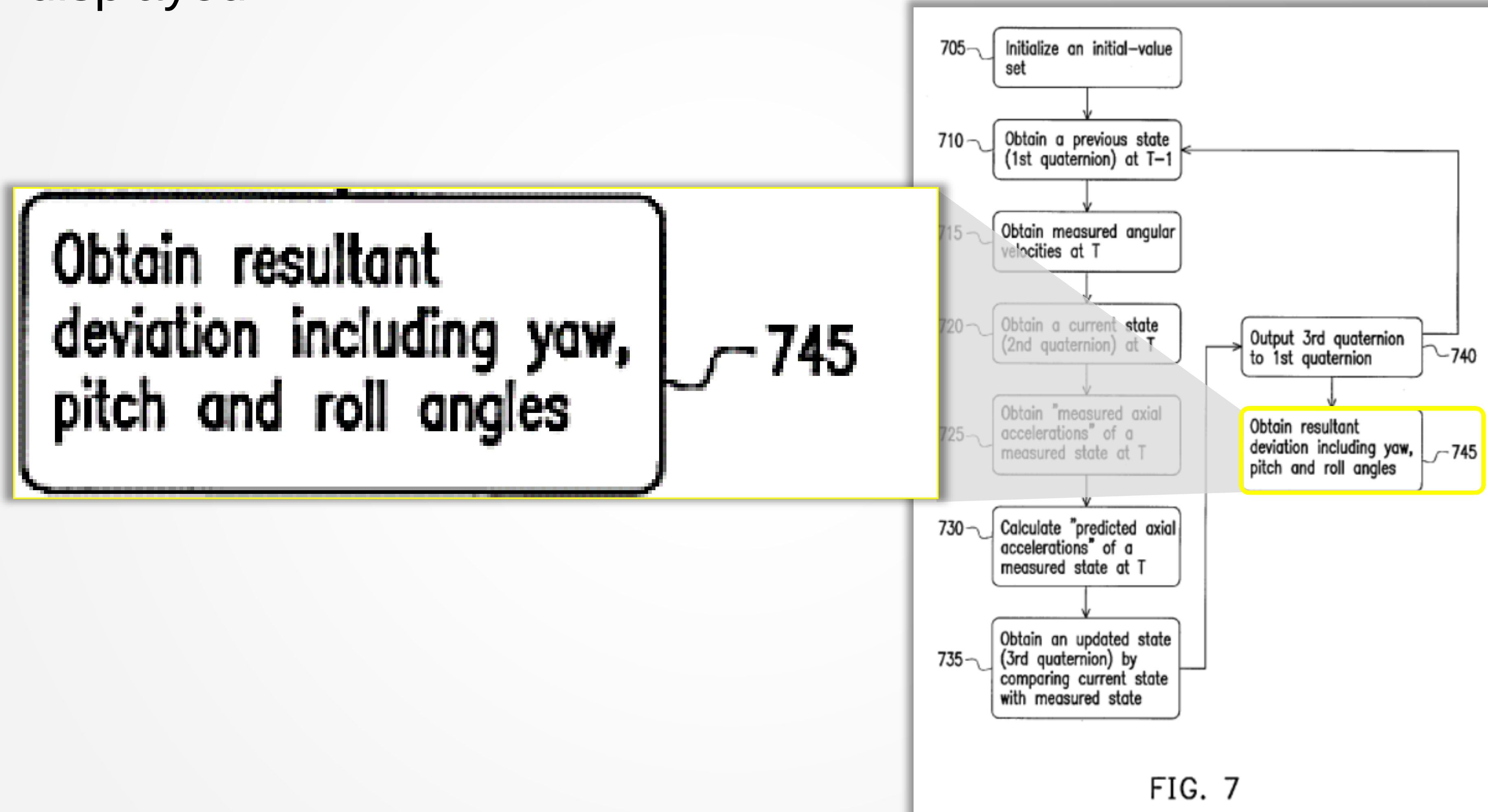
  SyncPoint Imaging, LLC v. Nintendo of Am. Inc., No. 2:15-cv-00247-JRG-RSP, 2016 WL 55118, at *9 (E.D. Tex. Jan. 5, 2016).



"three-dimensional (3D) pointing device"/"3D pointing device"

Samsung's Construction: "cursor or pointer"

None of the asserted claims require **any** information to be displayed.



'438 Patent Fig. 7

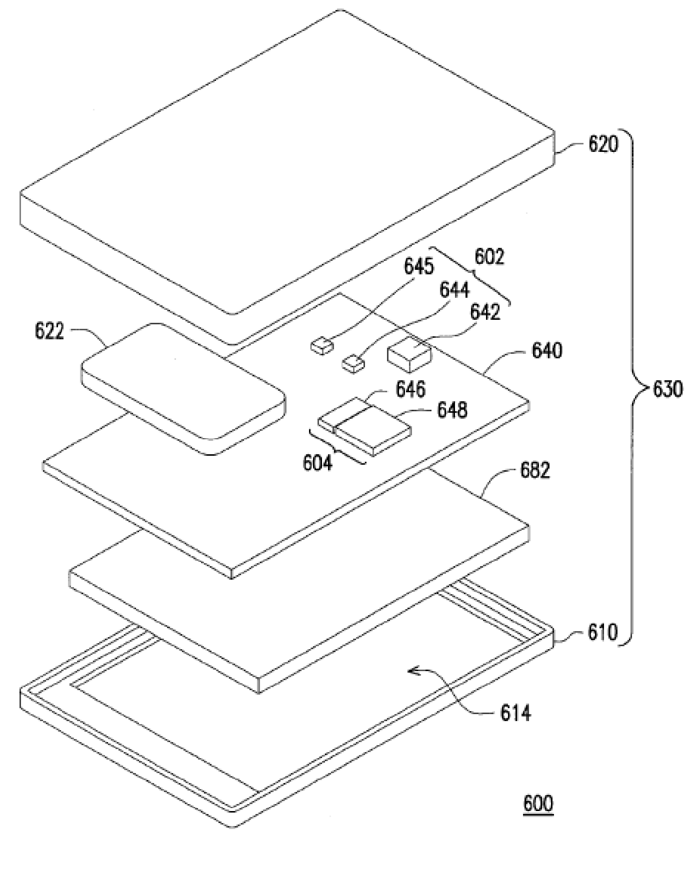
"three-dimensional (3D) pointing device"/"3D pointing device"

Samsung's Construction: "cursor or pointer"

But information **may** be displayed

The computing processor **648** of the processing and transmitting module **604** may too perform the mapping of resultant deviation from or in said spatial reference frame or 3D reference frame to a display reference frame such as a 2D reference frame by translating the resultant angles of the resulting

'438 Patent 10:29-39

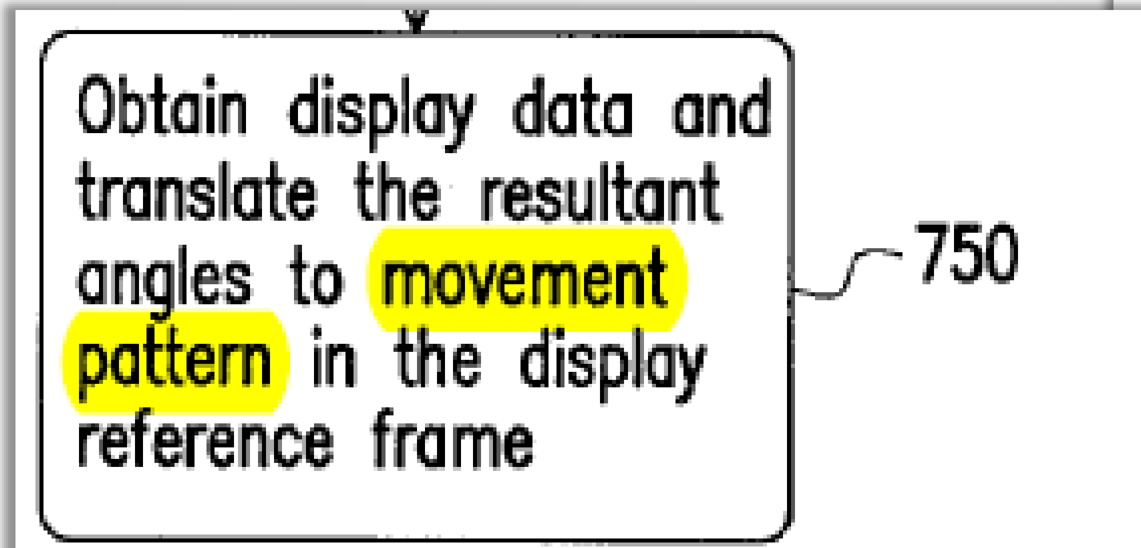


'438 Patent Fig. 6

"three-dimensional (3D) pointing device"/"3D pointing device"

Samsung's Construction: "cursor or pointer"

But information **may** be displayed



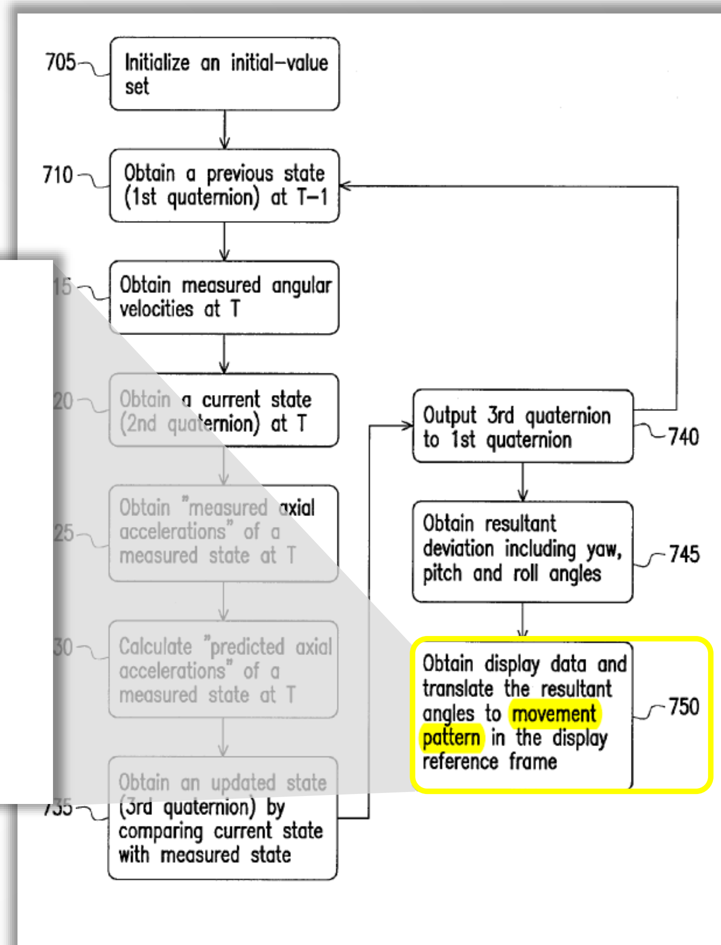


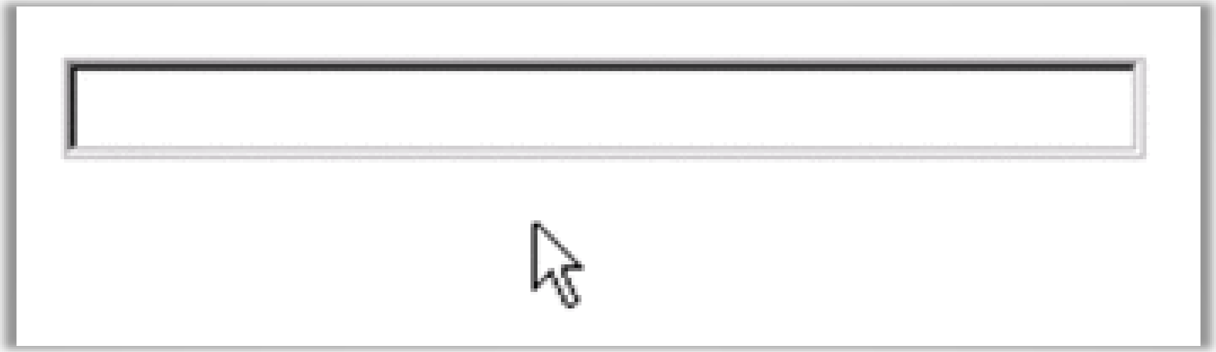
FIG. 8

'438 Patent Fig. 8

"three-dimensional (3D) pointing device"/"3D pointing device"

Samsung's Construction: "cursor or pointer"

If information is displayed, it need not be a cursor or pointer:



If information is displayed, it can be a **movement pattern:**

"three-dimensional (3D) pointing device"/"3D pointing device"

Disputed Terms from U.S. Patent No. 8,441,438

- “utilizing a comparison to compare the first signal set with the second signal set” (claim 1)
- “comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax’, Ay’, Az’ also at current time T” (claims 14, 19)
- “three-dimensional (3D) pointing device”/”3D pointing device” (claims 1, 3, 4, 5, 14, 15, 16, 17, 19)
- “six-axis motion sensor”/“six-axis motion sensor module” (claims 1, 5, 14, 15, 16, 17, 19)

Term within Claims 1, 5, 14, 15, 16, 17, 19

What is claimed is:

1. A three-dimensional (3D) pointing device subject to movements and rotations in dynamic environments, comprising:

a housing associated with said movements and rotations of the 3D pointing device in a spatial pointer reference frame;

a printed circuit board (PCB) enclosed by the housing;

a six-axis motion sensor module attached to the PCB, comprising a rotation sensor for detecting and generating a first signal set comprising angular velocities ω_x, ω_y, ω_z associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame, an accelerometer for detecting and generating a second signal set comprising axial accelerations Ax, Ay, Az associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame; and

a processing and transmitting module, comprising a data transmitting unit electrically connected to the six-axis motion sensor module for transmitting said first and second signal sets thereof and a computing processor for receiving and calculating said first and second signal sets from the data transmitting unit, communicating with the six-axis motion sensor module to calculate a resulting deviation comprising resultant angles in said spatial pointer reference frame by utilizing a comparison to compare the first signal set with the second signal set whereby said resultant angles in the spatial pointer reference frame of the resulting deviation of the six-axis motion sensor module of the 3D pointing device are obtained under said dynamic environments, wherein the comparison utilized by the processing and transmitting module further comprises an update program to obtain an updated state based on a previous state associated with said first signal set and a measured state associated with said second signal set; wherein the measured state includes a measurement of said second signal set and a predicted measurement obtained based on the first signal set without using any derivatives of the first signal set.

"six-axis motion sensor"/"six-axis motion sensor module"

Term within Claims 1, 5, 14, 15, 16, 17, 19

5. The 3D pointing device of claim **1**, wherein the data transmitting unit of the processing and transmitting module is attached to the PCB enclosed by the housing and transmits said first and second signal of the six-axis motion sensor module to the computing processor via electronic connections on the PCB.

14. A method for obtaining a resulting deviation including resultant angles in a spatial pointer reference frame of a three-dimensional (3D) pointing device utilizing a six-axis motion sensor module therein and subject to movements and rotations in dynamic environments in said spatial pointer reference frame, comprising the steps of:

obtaining a previous state of the six-axis motion sensor module; wherein the previous state includes an initial-value set associated with previous angular velocities gained from the motion sensor signals of the six-axis motion sensor module at a previous time T−1;

obtaining a current state of the six-axis motion sensor module by obtaining measured angular velocities ω_x, ω_y, ω_z gained from the motion sensor signals of the six-axis motion sensor module at a current time T;

obtaining a measured state of the six-axis motion sensor module by obtaining measured axial accelerations Ax, Ay, Az gained from the motion sensor signals of the six-axis motion sensor module at the current time T and calculating predicted axial accelerations Ax', Ay', Az' based on the measured angular velocities ω_x, ω_y, ω_z of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities ωx, ωy, ωz; said current state of the six-axis motion sensor module is a second quaternion with respect to said current time T; comparing the second quaternion in relation to the measured angular velocities ω_x, ω_y, ω_z of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T;

obtaining an updated state of the six-axis motion sensor module by comparing the current state with the measured state of the six-axis motion sensor module; and

calculating and converting the updated state of the six axis motion sensor module to said resulting deviation comprising said resultant angles in said spatial pointer reference frame of the 3D pointing device.

“six-axis motion sensor”/“six-axis motion sensor module”

Term within Claims 1, 5, 14, 15, 16, 17, 19

15. The method for obtaining a resulting deviation of a 3D pointing device of claim **14**, further comprises the step of outputting the updated state of the six-axis motion sensor module to the previous state of the six-axis motion sensor module; and wherein said resultant angles of the resulting deviation includes yaw, pitch and roll angles about each of three orthogonal coordinate axes of the spatial pointer reference frame.

16. The method for obtaining a resulting deviation of a 3D pointing device of claim **14**, wherein said previous state of the six-axis motion sensor module is a first quaternion with respect to said previous time T−1; and said updated state of the six-axis motion sensor module is a third quaternion with respect to said current time T.

17. The method for obtaining a resulting deviation of 3D pointing device of claim **14**, wherein the obtaining of said previous state of the six-axis motion sensor module further comprises initializing said initial-value set.

"six-axis motion sensor"/"six-axis motion sensor module"

Term within Claims 1, 5, 14, 15, 16, 17, 19

19. A method for obtaining a resulting deviation including resultant angles in a spatial pointer reference frame of a three-dimensional (3D) pointing device utilizing a six-axis motion sensor module therein and subject to movements and rotations in dynamic environments in said spatial pointer reference frame, comprising the steps of:

obtaining a previous state of the six-axis motion sensor module; wherein the previous state includes an initial-value set associated with previous angular velocities gained from the motion sensor signals of the six-axis motion sensor module at a previous time T−1;

obtaining a current state of the six-axis motion sensor module by obtaining measured angular velocities ω_x, ω_y, ω_z gained from the motion sensor signals of the six-axis motion sensor module at a current time T;

obtaining a measured state of the six-axis motion sensor module by obtaining measured axial accelerations A_x, A_y, A_z gained from the motion sensor signals of the six-axis motion sensor module at the current time T and calculating predicted axial accelerations $A_{x'}$, $A_{y'}$, $A_{z'}$ based on the measured angular velocities ω_x, ω_y, ω_z of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities ω_x, ω_y, ω_z; said current state of the six-axis motion sensor module is a second quaternion with respect to said current time T; comparing the second quaternion in relation to the measured angular velocities ω_x, ω_y, ω_z of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T;

obtaining an updated state of the six-axis motion sensor module by comparing the current state with the measured state of the six-axis motion sensor module; and

calculating and converting the updated state of the six axis motion sensor module to said resulting deviation comprising said resultant angles in said spatial pointer reference frame of the 3D pointing device.

“six-axis motion sensor”/“six-axis motion sensor module”

The Parties' Constructions

"six-axis motion sensor"/"six-axis motion sensor module"

CyWee's Construction	Samsung's Construction
This term need not be construed. In the alternative, this term may be construed as: "a collection of components comprising a rotation sensor comprising one or more gyroscopes for collectively generating three angular velocities and one or more accelerometers for collectively generating three axial accelerations where said gyroscope(s) and accelerometer(s) are mounted on a common PCB"	"a module consisting of two types of sensors: (i) a rotation sensor and (ii) one or more accelerometers"

CyWee's Alternative Construction

The terms "comprising" and "including" are **open-ended**

- "In the patent claim context the term 'comprising' is well understood to mean 'including but not limited to.'"

  CIAS, Inc. v. Alliance Gaming Corp., 504 F.3d 1356, 1360 (Fed. Cir. 2007)

CyWee's Alternative Construction

CyWee's construction ("comprising" and "including") is **open-ended**

a printed circuit board (PCB) enclosed by the housing;
a six-axis motion sensor module attached to the PCB, comprising a rotation sensor for detecting and generating a first signal set comprising angular velocities ω_x, ω_y, ω_z associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame, an accelerometer for detecting and generating a second signal set comprising axial accelerations Ax, Ay,

'438 Patent Claim 1

manner is provided. Said 3D pointing device comprises a six-axis motion sensor module including a rotation sensor and an accelerometer, and a processing and transmitting module. The six-axis motion sensor module generates a first sig-

'438 Patent Abstract

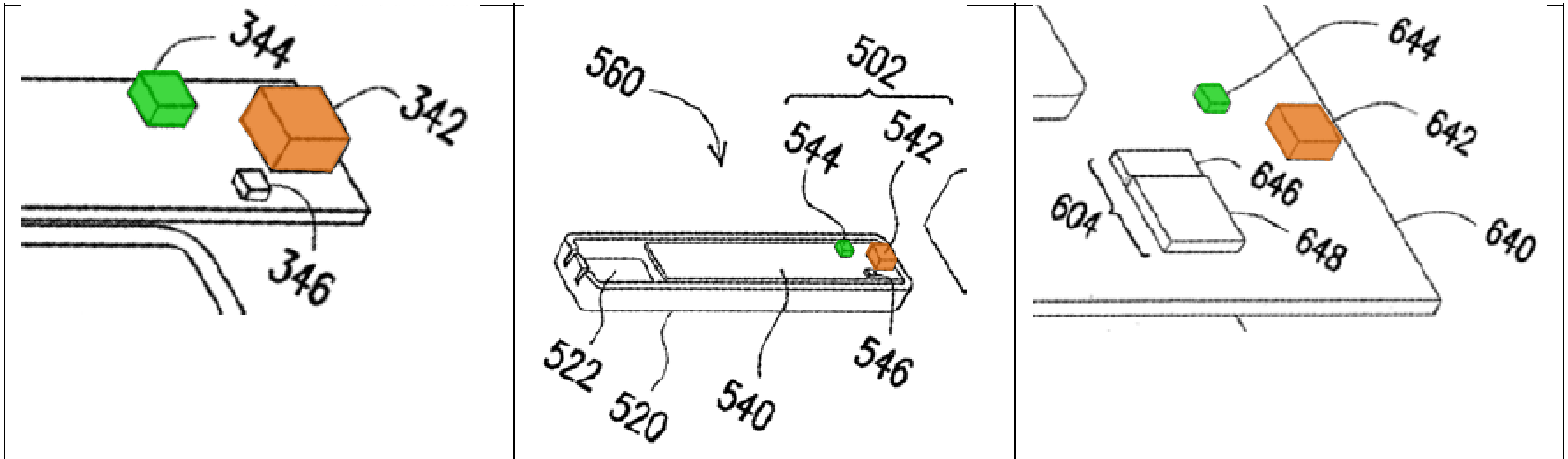
"six-axis motion sensor"/"six-axis motion sensor module"

Samsung's Construction is Closed-Ended

- "Consisting of" is closed-ended and not supported by claim language
- "Consisting of" implies that a six-axis motion sensor cannot include additional components
- The word "module" implies that a six-axis motion sensor cannot be comprised of separate components.
- "It is equally well understood in patent usage that 'consisting of' is closed-ended and conveys limitation and exclusion."

  CIAS, Inc. v. Alliance Gaming Corp., 504 F.3d 1356, 1361 (Fed. Cir. 2007)

Embodiments Support CyWee's Construction



Excerpt from Figure 3 | Excerpt from Figure 5 | Excerpt from Figure 6

342 - **Rotation Sensor**
344 - **Accelerometer**

542 - **Rotation Sensor**
544 - **Accelerometer**

642 - **Rotation Sensor**
644 - **Accelerometer**

"six-axis motion sensor"/"six-axis motion sensor module"

Samsung's Construction is Misleading

Samsung's construction provides no guidance as to the meaning of "rotation sensor"

accelerations of Ax, Ay, Az. It can be understood that in another preferred embodiment, the abovementioned rotation sensor may comprise three gyroscopes corresponding to each of the said angular velocities of ω_x, ω_y, ω_z in a 3D spatial pointer reference frame of the 3D pointing device; whereas

'438 Patent 5:23-26

Samsung's Reliance on the '978 Patent

> demarcation" between the '438 patent and the '978 patent. The Applicant's response indicates that the subject matter of the '978 Patent is differentiated by the fact that it requires a nine-axis motion sensor including a magnetometer with a measured output. In my opinion, this simply means that the '978 Patent requires a magnetometer with a measured output, whereas the '438 Patent contains no such requirement. This is confirmed by the patent's repeated use of the term "comprising" in claim 10.

LaViola Reply Decl. (Dkt. 71-1) ¶ 29.

- *Phillips v. AWH Corp., 415 F.3d 1303, 1317* (Fed. Cir. 2005) (holding that intrinsic evidence for a patent consists of ***its*** specification and file wrapper).
- *Smartphone Technologies LLC v. HTC Corp.*, No. 610cv580LEDJDL, 2013 WL 1136972, at *8 (E.D. Tex. March 18, 2013) (holding that nothing in child application "explicitly and unambiguously" narrowed the scope of parent applicaton).

Disputed Terms from U.S. Patent No. 8,552,978

- "generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set" (claim 10)
- "3D pointing device" (claim 10)
- "global reference frame associated with Earth" (claim 10)
- "using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device" (claim 10)

Term within Claim 10

US008552978B2

(12) **United States Patent**
Ye et al.

(10) **Patent No.:** **US 8,552,978 B2**
(45) **Date of Patent:** **Oct. 8, 2013**

(54) **3D POINTING DEVICE AND METHOD FOR COMPENSATING ROTATIONS OF THE 3D POINTING DEVICE THEREOF**

(75) Inventors: **Zhou Ye**, Foster City, CA (US); **Chin-Lung Li**, Taoyuan County (TW); **Shun-Nan Liou**, Kaohsiung (TW)

(73) Assignee: **Cywee Group Limited**, Tortola (VG)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 144 days.

(21) Appl. No.: **13/176,771**

(22) Filed: **Jul. 6, 2011**

(65) **Prior Publication Data**

US 2011/0260968 A1 Oct. 27, 2011

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/072,794, filed on Mar. 28, 2011, which is a continuation-in-part of application No. 12/943,934, filed on Nov. 11, 2010.

(60) Provisional application No. 61/292,558, filed on Jan. 6, 2010.

(51) **Int. Cl.**
G06F 3/033 (2013.01)
G09G 5/08 (2006.01)

(52) **U.S. Cl.**
USPC **345/157**; 345/156; 345/158; 345/173; 178/18.01; 178/18.03; 178/19.01

(58) **Field of Classification Search**
USPC ... 345/156–168, 173–183; 178/18.01–18.04, 178/19.01–19.04
See application file for complete search history.

(56) **References Cited**

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7,239,301 B2	7/2007	Liberty et al.		
7,262,760 B2	8/2007	Liberty		
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2009/0262074 A1*	10/2009	Nasiri et al.	....	345/158

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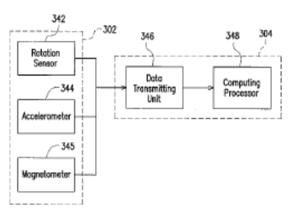
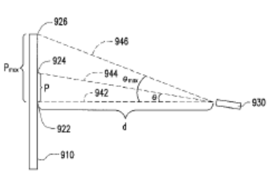
Primary Examiner — Lun-Yi Lao
Assistant Examiner — Insa Sadio
(74) *Attorney, Agent, or Firm* — Ding Yu Tan

(57) **ABSTRACT**

A 3D pointing device utilizing an orientation sensor, capable of accurately transforming rotations and movements of the 3D pointing device into a movement pattern in the display plane of a display device is provided. The 3D pointing device includes the orientation sensor, a rotation sensor, and a computing processor. The orientation sensor generates an orientation output associated with the orientation of the 3D pointing device associated with three coordinate axes of a global reference frame associated with the Earth. The rotation sensor generates a rotation output associated with the rotation of the 3D pointing device associated with three coordinate axes of a spatial reference frame associated with the 3D pointing device itself The computing processor uses the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with the display device above. The transformed output represents a segment of the movement pattern.

18 Claims, 12 Drawing Sheets





10. A method for compensating rotations of a 3D pointing device, comprising:

generating an orientation output associated with an orientation of the 3D pointing device associated with three coordinate axes of a global reference frame associated with Earth;

generating a first signal set comprising axial accelerations associated with movements and rotations of the 3D pointing device in the spatial reference frame;

generating a second signal set associated with Earth's magnetism; generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set;

generating a rotation output associated with a rotation of the 3D pointing device associated with three coordinate axes of a spatial reference frame associated with the 3D pointing device; and

using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device, wherein the orientation output and the rotation output is generated by a nine-axis motion sensor module; obtaining one or more resultant deviation including a plurality of deviation angles using a plurality of measured magnetisms Mx, My, Mz and a plurality of predicted magnetism Mx', My' and Mz' for the second signal set.

"generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set

The Parties' Constructions

"generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set

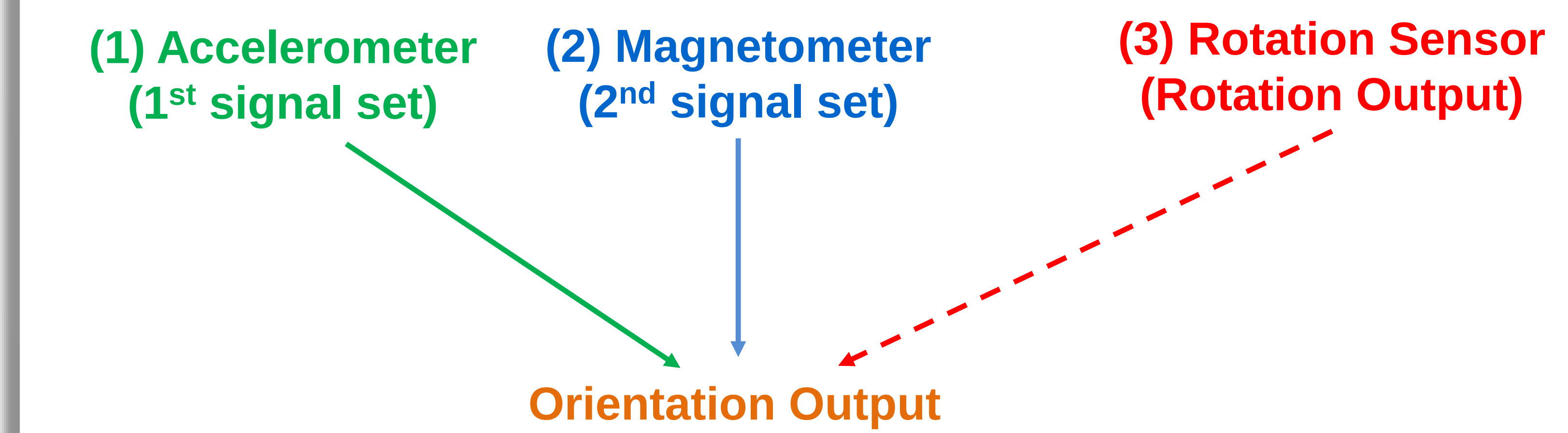
CyWee's Construction	Samsung's Construction
This term need not be construed. In the alternative, this term may be construed as: "generating the orientation/ deviation angle output based on (1) the first signal set (from an accelerometer), the second signal set (from a magnetometer) and the rotation output (from a rotation sensor or gyroscope) or (2) the first signal set (from an accelerometer) and the second signal set (from a magnetometer)."	Indefinite

"generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set

This Term Need Not be Construed

- This term ***need not be construed*** because persons, including laypersons, would understand the scope of the term with reasonable certainty.
- The term clearly requires that orientation is calculated based on **(1)**, **(2),** and optionally **(3)**.

generating the orientation output based on **(1) the first signal set**, **(2) the second signal set** and **(3) the rotation output** or based on **(1) the first signal set** and **(2) the second signal set**

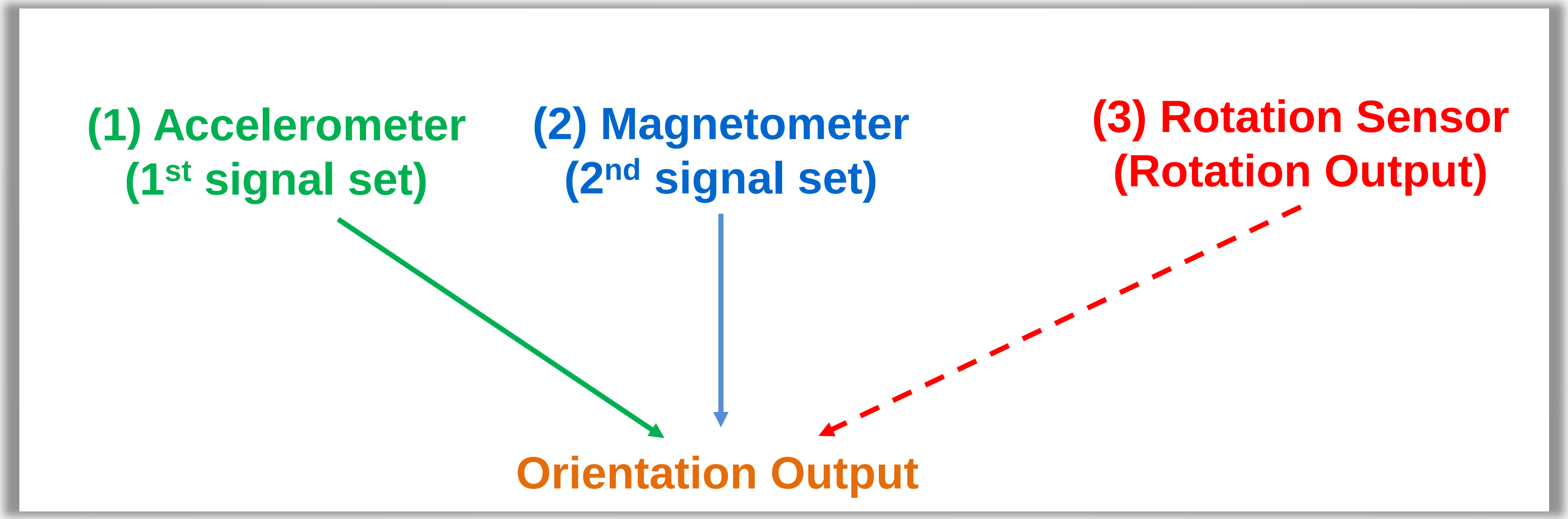


"generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set

CyWee's Alternative Construction

CyWee's alternative construction is consistent with the plain language of the claim:

"generating the orientation/ deviation angle output based on (1) **the first signal set (from an accelerometer)**, the **second signal set (from a magnetometer)** and the **rotation output (from a rotation sensor or gyroscope)** or (2) **the first signal set (from an accelerometer)** and the **second signal set (from a magnetometer)**."



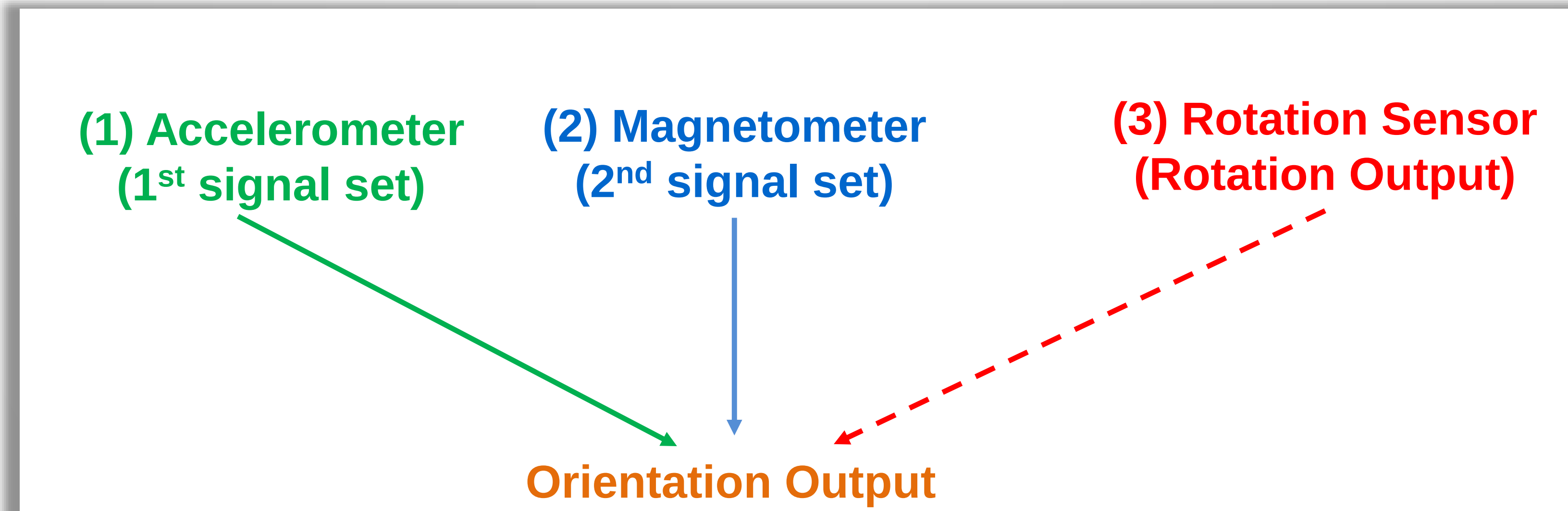
"generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set

CyWee's Alternative Construction

> The computing processor **348** may generate the aforementioned orientation output in the form of a rotation matrix, a quaternion, a rotation vector, or in a form including the three orientation angles yaw, pitch and roll. The orientation output

'978 patent 31:4-7

This is reflected in CyWee's construction which requires a **orientation/deviation angle output**.



"generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set

Term within Claim 10

The parties' experts agree that orientation can be calculated, ***for a stationary device***, with data from only an accelerometer and magnetometer using Equations 26-28 from the '978 patent.

199. A POSA would have understood that it is only mathematically possible to generate an orientation output based on "axial accelerations" and magnetism readings if the axial accelerations are interpreted to be based exclusively on the gravitational accelerations.

Mercer Dec. (Dkt. 67-1)

95. The '978 patent discloses how to calculate orientation using the axial accelerations (roll and pitch) and the magnetometer measurements (yaw) in Equations 26-28. A person of ordinary skill in the art would understand that the axial accelerations would be based on gravitation in Equations 26-28. Axial accelerations would be based solely on gravitational accelerations when the device is stationary.

LaViola Dec. (Dkt. 66-1)

214. I do not disagree that when a device is stationary, the only acceleration that would be read from an accelerometer would be from gravitational force. However, Dr. LaViola does not

Mercer Dec. (Dkt. 67-1)

"generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set

Term within Claim 10

Based on Equations 26-28, Claim 10 reads on and covers a device that:

1. Calculates orientation based solely on an accelerometer and magnetometer when the device is ***stationary***; and
2. Calculates orientation based on an accelerometer, gyroscope, and magnetometer when said device is ***moving***.

"generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set

CyWee's Invention Also Covers Devices that Determine Orientation Based on an Accelerometer and Gyroscope While Moving

A person of ordinary skill in the art would understand that claim 10 also covers a device that determines orientation using an ***accelerometer and magnetometer while moving***, using Equations 5-11 as a blueprint or framework:

28. In the '978 patent, to obtain deviation angles of the 3D pointing device when it is moving by using accelerometers and magnetometers, a person of ordinary skill in the art would use Equations (5-11) as a blueprint for the "enhanced comparison method" and construct the process and measurement models using the acceleration and magnetometer sensors. This filter is considered to be another embodiment of the "enhanced comparison method." This is clearly stated in the '978 patent: "In one example, external forces exerted to cause axial accelerations of a nine-axis motion sensor of an electronic device of the present invention may be decoupled or separated from a force of gravity; and in another example, the undesirable magnetism caused by such as electromagnetic fields external or internal to an electronic device the present invention may be excluded. It can be understood that the examples of current state, measured state, state update, data association and probabilities of the comparison model and method of the present invention recited herein are provided for illustrative purposes only." '978 patent 18:44-55. The "enhanced comparison method" blueprint, described in Equations (5-11), provide for this flexibility. Thus, Dr. Mercer's arguments are not valid, and the term is not indefinite.

"generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set

Samsung and its Expert's Grounds of Indefiniteness

Samsung's arguments #1 and #2 mimic those it used for its allegations of indefiniteness for two terms in the '438 patent.

1. The claim does not state the precise type of axial acceleration.

2. An accelerometer cannot distinguish between the three types of axial acceleration (gravitational, linear, centrifugal).

3. Generating an orientation output based on axial accelerations and magnetisms is mathematically impossible for a moving device (see prior slides).

Unlike the claims of at issue in the '438 patent, this term does not recite a "comparison."

"generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set

Samsung's First Ground

1. The claim does not state the precise type of axial acceleration.

Samsung is mistaken because the patent readily acknowledges the different types of acceleration and the enhanced comparison method addresses those differences.

"generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set

Samsung's Second Ground

2. An accelerometer cannot distinguish between the three types of axial acceleration (gravitational, linear, centrifugal).

The patent does not require this.

"generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set

Defendants Readily Understand this Term

- Samsung had no problem understanding this term when submitting its lengthy invalidity contentions.
- Apple had no difficulty understanding this term in the case against in the Northern District of California.

“generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set

Disputed Terms from U.S. Patent No. 8,552,978

- “generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set” (claim 10)
- “3D pointing device” (claim 10)
- “global reference frame associated with Earth” (claim 10)
- “using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device” (claim 10)

Term within Claim 10

US008552978B2

(12) **United States Patent**
Ye et al.

(10) **Patent No.:** **US 8,552,978 B2**
(45) **Date of Patent:** **Oct. 8, 2013**

(54) **3D POINTING DEVICE AND METHOD FOR COMPENSATING ROTATIONS OF THE 3D POINTING DEVICE THEREOF**

(75) Inventors: **Zhou Ye**, Foster City, CA (US); **Chin-Lung Li**, Taoyuan County (TW); **Shun-Nan Liou**, Kaohsiung (TW)

(73) Assignee: **Cywee Group Limited**, Tortola (VG)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 144 days.

(21) Appl. No.: **13/176,771**

(22) Filed: **Jul. 6, 2011**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(51) **Int. Cl.**
G06F 3/033 (2013.01)
G09G 5/08 (2006.01)

(52) **U.S. Cl.**
USPC **345/157**; 345/156; 345/158; 345/173; 178/18.01; 178/18.03; 178/19.01

(58) **Field of Classification Search**
USPC ... 345/156–168, 173–183; 178/18.01–18.04, 178/19.01–19.04
See application file for complete search history.

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7,414,611	B2	8/2008	Liberty	
2009/0262074	A1 *	10/2009	Nasiri et al.	345/158

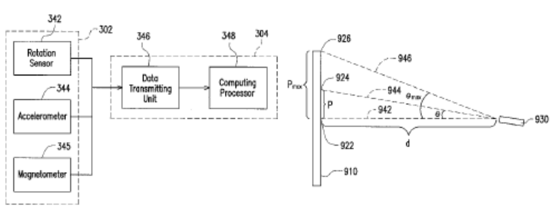
* cited by examiner

Primary Examiner — Lun-Yi Lao
Assistant Examiner — Insa Sadio
(74) *Attorney, Agent, or Firm* — Ding Yu Tan

(57) **ABSTRACT**

A 3D pointing device utilizing an orientation sensor, capable of accurately transforming rotations and movements of the 3D pointing device into a movement pattern in the display plane of a display device is provided. The 3D pointing device includes the orientation sensor, a rotation sensor, and a computing processor. The orientation sensor generates an orientation output associated with the orientation of the 3D pointing device associated with three coordinate axes of a global reference frame associated with the Earth. The rotation sensor generates a rotation output associated with the rotation of the 3D pointing device associated with three coordinate axes of a spatial reference frame associated with the 3D pointing device itself The computing processor uses the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with the display device above. The transformed output represents a segment of the movement pattern.

18 Claims, 12 Drawing Sheets



10. A method for compensating rotations of a 3D pointing device, comprising:

generating an orientation output associated with an orientation of the 3D pointing device associated with three coordinate axes of a global reference frame associated with Earth;

generating a first signal set comprising axial accelerations associated with movements and rotations of the 3D pointing device in the spatial reference frame;

generating a second signal set associated with Earth's magnetism; generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set;

generating a rotation output associated with a rotation of the 3D pointing device associated with three coordinate axes of a spatial reference frame associated with the 3D pointing device; and

using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device, wherein the orientation output and the rotation output is generated by a nine-axis motion sensor module; obtaining one or more resultant deviation including a plurality of deviation angles using a plurality of measured magnetisms Mx, My, Mz and a plurality of predicted magnetism Mx', My' and Mz' for the second signal set.

"3D pointing device"

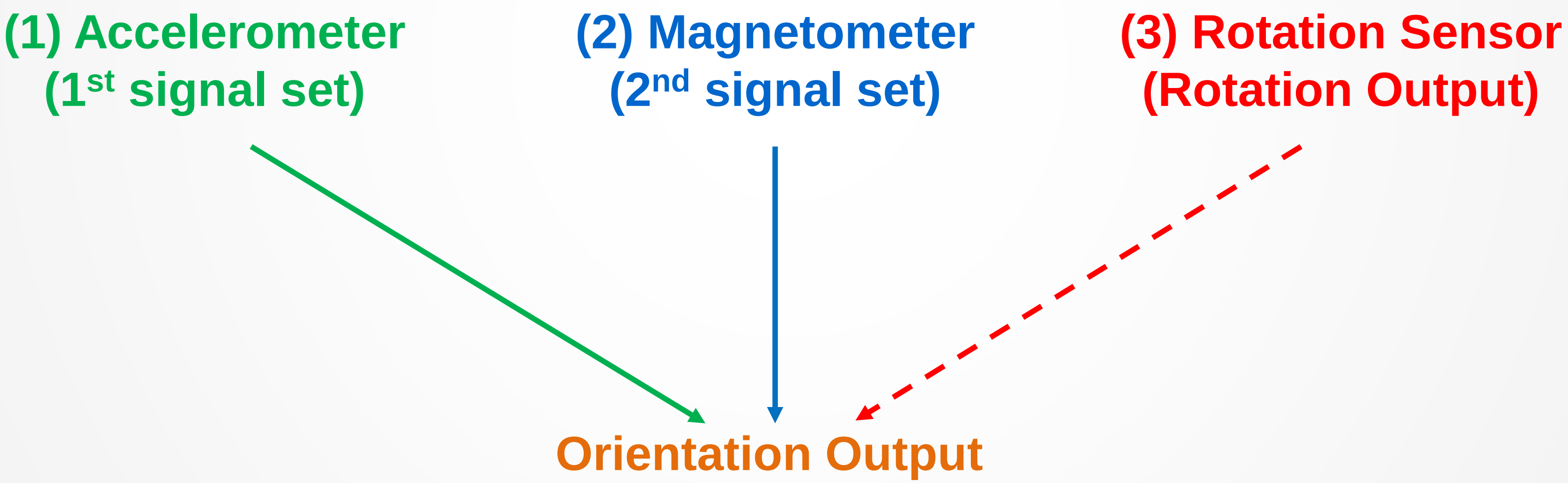
The Parties' Constructions

"3D pointing device"

CyWee's Construction	Samsung's Construction
This term need not be construed. In the alternative, this term may be construed as: "a handheld device that includes at least one or more accelerometers and a magnetometer, and optionally a rotation sensor comprising one more gyroscopes, and uses them to determine deviation angles or the orientation of a device"	"a device that detects the motion of the device in three-dimensions and translates the detected motions to control the movement of a cursor or pointer on a display"

CyWee's Alternative Construction

CyWee's alternative construction is consistent with the plain language of the claim: "generating the orientation/ deviation angle output based on (1) **the first signal set (from an accelerometer)**, the **second signal set (from a magnetometer)** and the **rotation output (from a rotation sensor or gyroscope)** or (2) **the first signal set (from an accelerometer)** and the **second signal set (from a magnetometer)**."



"3D pointing device"

Disputed Terms from U.S. Patent No. 8,552,978

- “generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set” (claim 10)
- “3D pointing device” (claim 10)
- “global reference frame associated with Earth” (claim 10)
- “using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device” (claim 10)

Term within Claim 10

(12) **United States Patent**
Ye et al.

(10) **Patent No.: US 8,552,978 B2**
(45) **Date of Patent: Oct. 8, 2013**

US008552978B2

(54) **3D POINTING DEVICE AND METHOD FOR COMPENSATING ROTATIONS OF THE 3D POINTING DEVICE THEREOF**

(75) Inventors: **Zhou Ye**, Foster City, CA (US); **Chin-Lung Li**, Taoyuan County (TW); **Shun-Nan Liou**, Kaohsiung (TW)

(73) Assignee: **Cywee Group Limited**, Tortola (VG)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 144 days.

(21) Appl. No.: **13/176,771**

(22) Filed: **Jul. 6, 2011**

(65) **Prior Publication Data**

US 2011/0260968 A1 Oct. 27, 2011

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/072,794, filed on Mar. 28, 2011, which is a continuation-in-part of application No. 12/943,934, filed on Nov. 11, 2010.

(60) Provisional application No. 61/292,558, filed on Jan. 6, 2010.

(51) **Int. Cl.**
G06F 3/033 (2013.01)
G09G 5/08 (2006.01)

(52) **U.S. Cl.**
USPC **345/157**; 345/156; 345/158; 345/173; 178/18.01; 178/18.03; 178/19.01

(58) **Field of Classification Search**
USPC ... 345/156–168, 173–183; 178/18.01–18.04, 178/19.01–19.04
See application file for complete search history.

(56) **References Cited**

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5,440,326	A	8/1995	Quinn	
5,898,421	A	4/1999	Quinn	
7,158,118	B2	1/2007	Liberty	
7,236,156	B2	6/2007	Liberty et al.	
7,239,301	B2	7/2007	Liberty et al.	
7,262,760	B2	8/2007	Liberty	
7,414,611	B2	8/2008	Liberty	
2009/0262074	A1 *	10/2009	Nasiri et al.	345/158

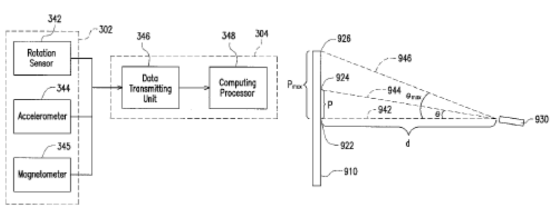
* cited by examiner

Primary Examiner — Lun-Yi Lao
Assistant Examiner — Insa Sadio
(74) *Attorney, Agent, or Firm* — Ding Yu Tan

(57) **ABSTRACT**

A 3D pointing device utilizing an orientation sensor, capable of accurately transforming rotations and movements of the 3D pointing device into a movement pattern in the display plane of a display device is provided. The 3D pointing device includes the orientation sensor, a rotation sensor, and a computing processor. The orientation sensor generates an orientation output associated with the orientation of the 3D pointing device associated with three coordinate axes of a global reference frame associated with the Earth. The rotation sensor generates a rotation output associated with the rotation of the 3D pointing device associated with three coordinate axes of a spatial reference frame associated with the 3D pointing device itself The computing processor uses the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with the display device above. The transformed output represents a segment of the movement pattern.

18 Claims, 12 Drawing Sheets



10. A method for compensating rotations of a 3D pointing device, comprising:

generating an orientation output associated with an orientation of the 3D pointing device associated with three coordinate axes of a global reference frame associated with Earth;

generatinq a first signal set comprising axial accelerations associated with movements and rotations of the 3D pointing device in the spatial reference frame;

generating a second signal set associated with Earth's magnetism; generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set;

generating a rotation output associated with a rotation of the 3D pointing device associated with three coordinate axes of a spatial reference frame associated with the 3D pointing device; and

using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device, wherein the orientation output and the rotation output is generated by a nine-axis motion sensor module; obtaining one or more resultant deviation including a plurality of deviation angles using a plurality of measured magnetisms Mx, My, Mz and a plurality of predicted magnetism Mx', My' and Mz' for the second signal set.

"global reference frame associated with Earth"

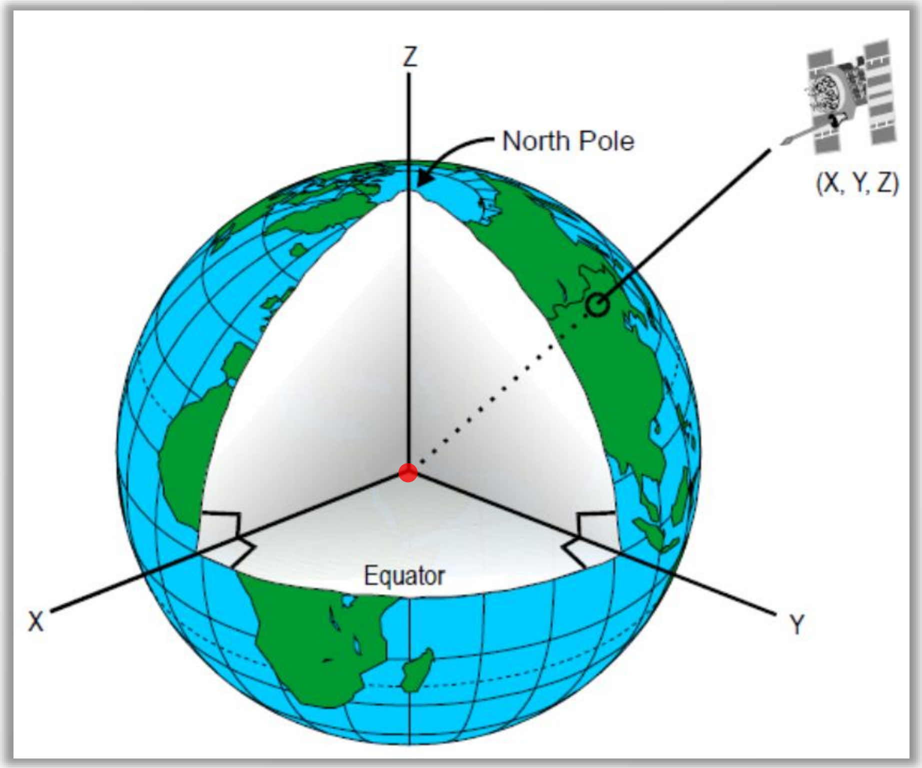
The Parties' Constructions

"global reference frame associated with Earth"

CyWee's Construction	Samsung's Construction
This term need not be construed. In the alternative, this term may be construed as: "reference frame with axes defined with respect to Earth"	"an Earth-centered coordinate system with an origin and a set of three coordinate axes defined with respect to Earth"

Language of the Claim

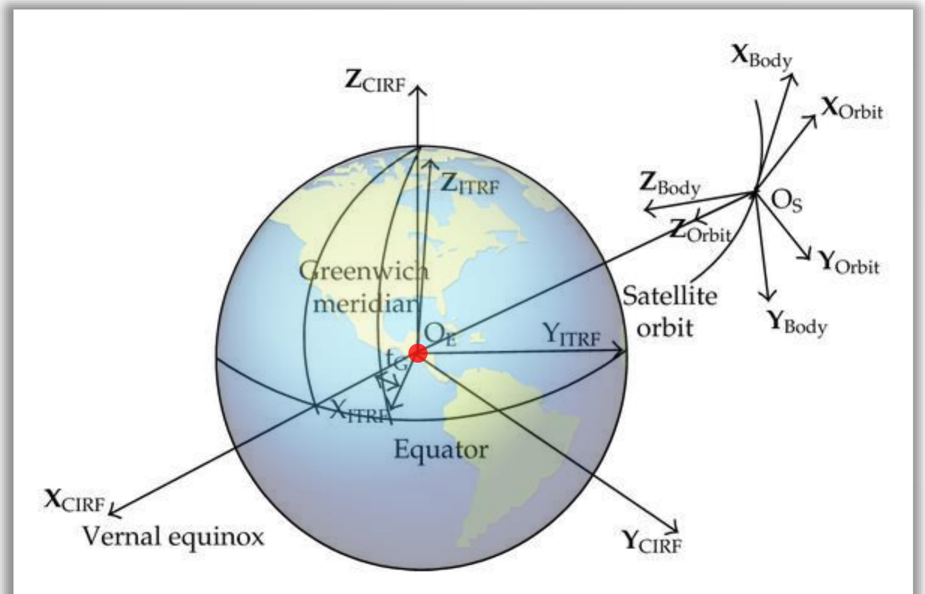
- The term "***a*** global reference frame ***associated with*** the Earth" is broad.
- When construing claim terms "[f]irst we look to the words of the claims themselves . . . to define the scope of the patented invention."
  Vitronics Corp. v. Conceptronic, Inc., 90 F.3d 1576, 1582 (Fed. Cir. 1996).
- Samsung's points to no disclaimer in the '978 patent and limits its construction to the following:



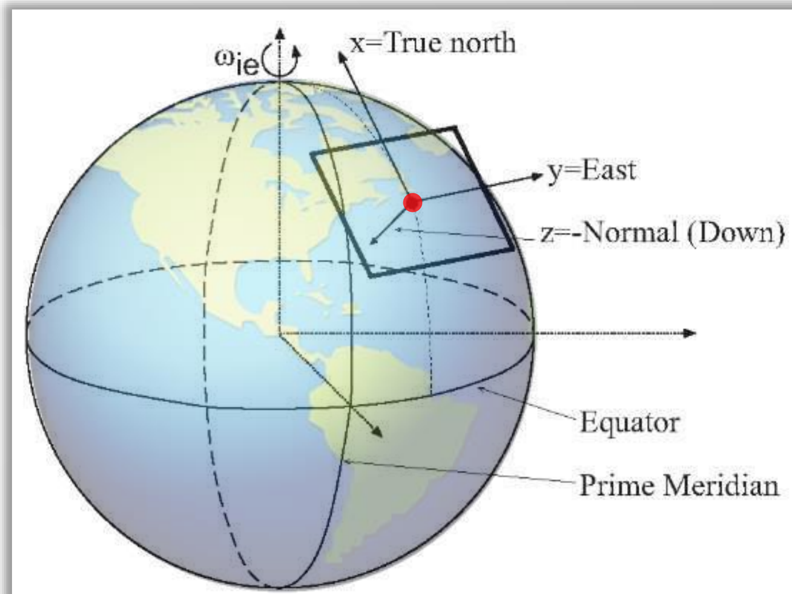
"global reference frame associated with Earth"

Difference Between Constructions

Samsung's construction is limited to this:



CyWee's construction allows for other frames, such as the ENU frame:



Both of the above examples are ***Earth-based*** with an axis (z) pointing towards the center of the Earth.

"global reference frame associated with Earth"

Expert Testimony

- "[A] trial court is quite correct in . . . relying on expert testimony on an ultimate claim construction question in cases in which the intrinsic evidence . . . does not answer the question."

  Key Pharm. v. Hercon Labs. Corp., 161 F.3d 709, 716 (Fed. Cir. 1998).

- The ***only*** party to provide expert testimony on this term is CyWee.
  - Samsung did not ask Dr. LaViola a single question regarding his opinion on this term.

"global reference frame associated with Earth"

Expert Testimony

H. "global reference frame associated with Earth" ('978 patent claim 10)

108. CyWee contends that this term need not be construed. In the alternative, CyWee contends that this term should be construed as "reference frame with axes defined with respect to the Earth." Samsung proposes that this term be construed as "an Earth-centered coordinate system with an origin and a set of three coordinate axes defined with respect to Earth." In my opinion, this term has the meaning proposed by CyWee.

109. In my opinion, Samsung's proposed construction is overly narrow. "Earth-

LaViola Dec. (Dkt. 66-6)

Expert Testimony

B. "global reference frame associated with Earth" ('978 patent claim 10)

30. The term "global reference frame" or "global frame of reference" is a commonly used term in the art, which refers to a fixed frame, against which the position and orientation of moving frames can be measured. A person of ordinary skill in the art would understand that there are many valid "global reference frames" and would further understand that, while an example of global reference is an Earth-centered frame, that is ***not the only type*** of global reference frame. Similarly, a person of ordinary skill in the art would not read the term "global reference frame associated with the Earth" as being limited solely to a reference frame with an axis at or near the center of the Earth.

32. CyWee's construction does not eliminate the term "global" as alleged by Samsung simply because it allows for an origin occurring at or near different locations of the globe. There is no indication in the patent that it is so-limited, and my review of materials cited by both CyWee and Samsung confirms my opinion.

LaViola Reply Dec. (Dkt. 71-1)

"global reference frame associated with Earth"

Samsung's Allegation that CyWee's Construction Eliminates Requirement of Three Axes is Incorrect

First, Samsung's construction requires three coordinate axes, while CyWee's merely requires "axes." The '978 Patent, however, explicitly states in numerous places that a "global reference frame" must comprise a set of "three coordinate axes." For example, the '978 Patent describes one

Samsung's Responsive Brief (Dkt. 67) at p. 26.

The longer phrase of which this term is a part expressly requires that the global reference frame include ***three*** coordinate axes.

10. A method for compensating rotations of a 3D pointing device, comprising:
generating an orientation output associated with an orientation of the 3D pointing device associated with three coordinate axes of a global reference frame associated with Earth;

'978 Patent Claim 10

10. A method for compensating rotations of a 3D pointing device, comprising:
generating an orientation output associated with an orientation of the 3D pointing device associated with three coordinate axes of a reference frame with axes defined with respect to Earth;

'978 Patent Claim 14 with CyWee's construction

"global reference frame associated with Earth"

Disputed Terms from U.S. Patent No. 8,552,978

- "generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set" (claim 10)
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Term within Claim 10

US008552978B2

(12) **United States Patent**
Ye et al.

(10) **Patent No.: US 8,552,978 B2**
(45) **Date of Patent: Oct. 8, 2013**

(54) **3D POINTING DEVICE AND METHOD FOR COMPENSATING ROTATIONS OF THE 3D POINTING DEVICE THEREOF**

(75) Inventors: **Zhou Ye**, Foster City, CA (US); **Chin-Lung Li**, Taoyuan County (TW); **Shun-Nan Liou**, Kaohsiung (TW)

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7,239,301	B2	7/2007	Liberty et al.	
7,262,760	B2	8/2007	Liberty	
7,414,611	B2	8/2008	Liberty	
2009/0262074	A1 *	10/2009	Nasiri et al.	345/158

* cited by examiner

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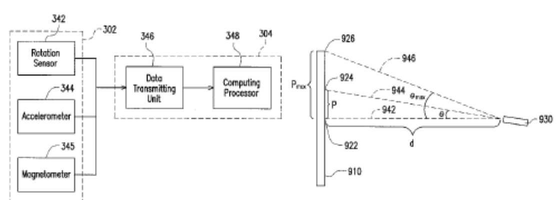
(57) **ABSTRACT**

A 3D pointing device utilizing an orientation sensor, capable of accurately transforming rotations and movements of the 3D pointing device into a movement pattern in the display plane of a display device is provided. The 3D pointing device includes the orientation sensor, a rotation sensor, and a computing processor. The orientation sensor generates an orientation output associated with the orientation of the 3D pointing device associated with three coordinate axes of a global reference frame associated with the Earth. The rotation sensor generates a rotation output associated with the rotation of the 3D pointing device associated with three coordinate axes of a spatial reference frame associated with the 3D pointing device itself The computing processor uses the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with the display device above. The transformed output represents a segment of the movement pattern.

18 Claims, 12 Drawing Sheets



10. A method for compensating rotations of a 3D pointing device, comprising:

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generatinq a first signal set comprising axial accelerations associated with movements and rotations of the 3D pointing device in the spatial reference frame;

generating a second signal set associated with Earth's magnetism; generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set;

generating a rotation output associated with a rotation of the 3D pointing device associated with three coordinate axes of a spatial reference frame associated with the 3D pointing device; and

using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device, wherein the orientation output and the rotation output is generated by a nine-axis motion sensor module; obtaining one or more resultant deviation including a plurality of deviation angles using a plurality of measured magnetisms Mx, My, Mz and a plurality of predicted magnetism Mx', My' and Mz' for the second signal set.

"using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device"

The Parties' Constructions

"using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device"

CyWee's Construction	Samsung's Construction
"using the orientation output and the rotation output to generate a transformed output ***represented by*** 2-dimensional movement in a fixed reference frame that is parallel to the screen of a display device"	"using the orientation output and the rotation output to generate a transformed output ***representing a*** two-dimensional movement in a fixed reference frame that is parallel to the screen of the display device"

"using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device"

Samsung's Construction Improperly Excludes 3D Movement

"using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device"

Law of Disclaimer

- To disavow claim scope, the specification must contain expressions of manifest exclusion or restriction, representing a clear disavowal of claim scope.

  Retractable Techs., Inc. v. Becton, Dickinson & Co., 653 F.3d 1296, 1306 (Fed. Cir. 2011).

- No disclaimer is present here.

"using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device"

Samsung's Construction Originates from a Single Embodiment Having a Separate Pointer and Display

In step **1340**, the rotation sensor **342** generates a rotation output associated with the rotation of the 3D pointing device associated with the three coordinate axes of a spatial reference frame associated with the 3D pointing device itself (such as the reference frame $X_P Y_P Z_P$ shown in FIG. **1** and FIG. **2**). In step **1360**, the computing processor **1420** uses the orientation output and the rotation output to generate a transformed output $<d_x, d_y>$ associated with the fixed reference frame associated with the display device. The transformed output $<d_x, d_y>$ represents a 2-dimensional movement in a display plane in the fixed reference frame parallel to the screen of the display device, such as the display plane $X_D Y_D$ of the display device **120** shown in FIG. **1** and FIG. **2**, wherein d_x represents the movement along the X_D axis and d_y represents the movement along the Y_D axis. In addition, the transformed output

978 patent 31:51-65

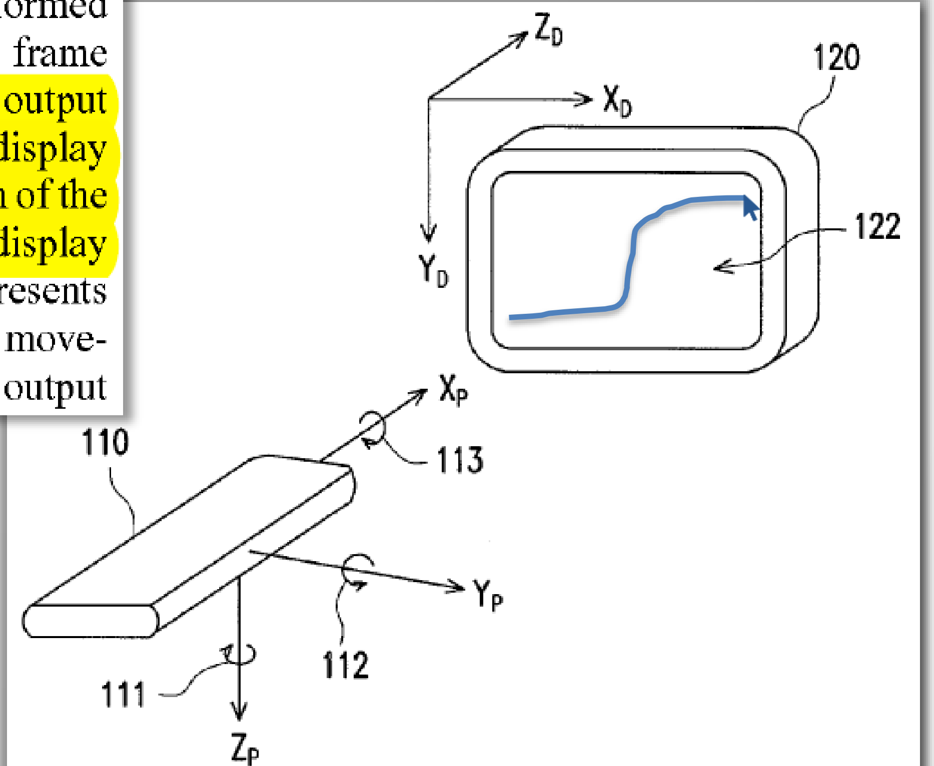

FIG. 1 (RELATED ART)

"using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device"

Samsung's Construction is Nonsensical for an 3D Pointing Device Having a Screen, Such as a Cellular Phone

reference frame. The portable electronic device **600** may further comprises a built-in display **682**; examples of the portable electronic device **600** as an explanatory embodiment of the present invention may include such as smartphone, tablet PC or navigation equipment. In other words, the above-

The device is not pointing at itself, so requiring that the transformed output solely represent 2D movement is improper.

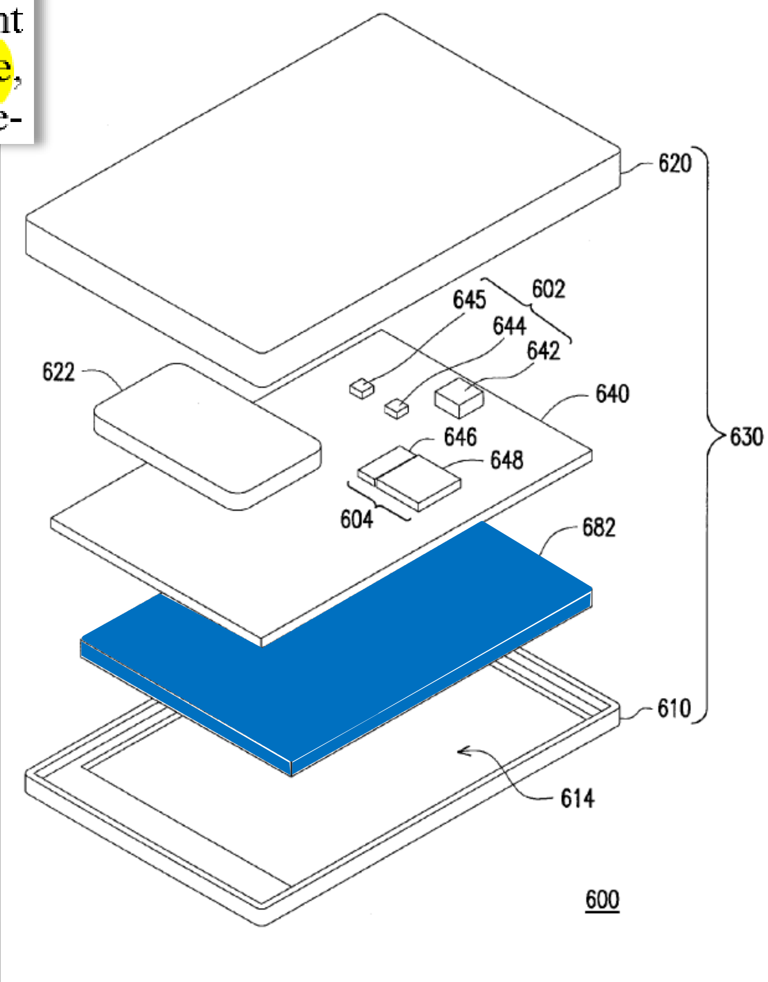

FIG. 6

"using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device"

Samsung's Construction is Nonsensical for an 3D Pointing Device Having a Screen, Such as a Cellular Phone

The computing processor **648** of the processing and transmitting module **604** may too perform the mapping of resultant deviation from or in said spatial reference frame or 3D reference frame to a display reference frame such as a 2D reference frame by translating the resultant angles of the resulting deviation of the electronic device **600** in the spatial reference frame, preferably about each of three orthogonal coordinate axes of the spatial reference frame to a movement pattern in a display reference frame associated with the electronic device **600** itself. The display **682** displays the aforementioned movement pattern. The top cover **610** includes a transparent area **614** for the user to see the display **682**.

The embodiment of Figure 6 describes showing a movement pattern associated with 3D (not 2D) movement.

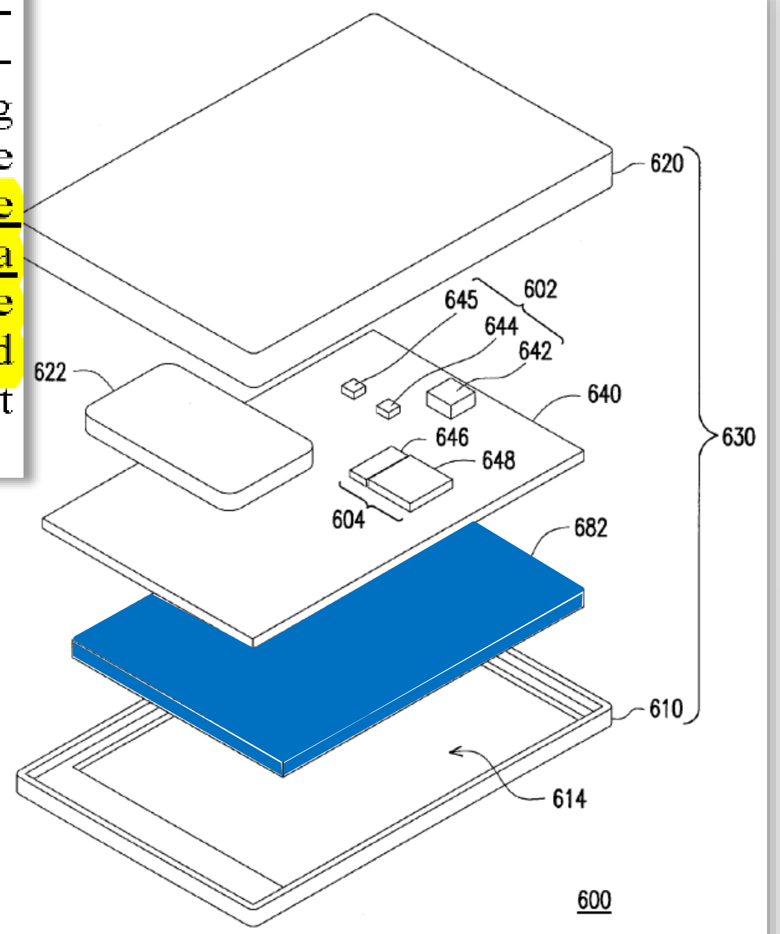

FIG. 6

"using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device"

The Movement Pattern May Represent 3D Movement

furthermore, based on the deviation angles being compensated and accurately outputted in 3D spatial reference frame may be further mapped onto or translated into another reference frame such as the abovementioned display frame, for example a reference in two-dimension (2D).

’978 patent 5:41-45.

Thank You